TWENTIETH ANNUAL REPORT

OF THE

BOARD

OF

Water Commissioners

OF THE

CITY OF ST. PAUL.

JANUARY 1, 1902.

ST. PAUL, MINN.
THE PIONEER PRESS COMPANY
1902.

TWENTIETH ANNUAL REPORT

OF THE

BOARD

OF

Water Commissioners

COMPLIMENTS OF

THE BOARD OF
WATER COMMISSIONERS.

JOHN CAULFIELD,
SECRETARY.

PLEASE EXCHANGE.

ST. PAUL, MINN.
THE PIONEER PRESS COMPANY
1902.

OFFICERS

OF THE

CITY WATER WORKS.

JANUARY 1, 1902.

BOARD OF WATER COMMISSIONERS.

JNO. M. CARLSON. Term expires Jan. 1, 1903.
J. C. DONAHOWER. Term expires Jan. 1, 1904.
THOMAS GRACE. Term expires Jan. 1, 1905.
CRAWFORD LIVINGSTON, President. Term expires Jan. 1, 1906.
JNO. J. DWYER. Term expires Jan. 1, 1907.

JOHN CAULFIELD, Secretary.
JOHN LINDQUIST, Superintendent.
OSCAR CLAUSSEN, City Engineer and Engineer of the Board.
MARTIN FEIST, Chief Engineer and Engineer of McCarron Lake Station.
M. THOMMES, Assistant Engineer of McCarron Lake Station.
FRED KOPHINGST, Assistant Engineer of McCarron Lake Station.
JOHN DREWERY, Assistant Engineer of McCarron Lake Station.
A. A. THOMPSON, Gate Keeper and Engineer of Vadnais Lake Station.
JACOB ABRESCH, Engineer of Centerville Station.
JOS. DOERR, Engineer of West St. Paul Station.
HERMANN GEISSLER, Assistant Engineer of West St. Paul Station.
GEO. DOORLEY, Chief of Meter Department.

TWENTIETH ANNUAL REPORT

OF THE

Board of Water Commissioners

OF THE

CITY OF ST. PAUL, MINN.

OFFICE OF THE BOARD OF WATER COMMISSIONERS,
ST. PAUL, MINN., Jan. 1, 1902.

To the Honorable Mayor and Common Council of the City of St. Paul, Minn.,

GENTLEMEN: The Board of Water Commissioners of the City of St. Paul herewith presents its twentieth (20th) annual report for the year ending Dec. 31, 1901, together with the reports of the secretary, superintendent, city engineer, chief engineer of the mechanical department, chief of the meter department and city treasurer. A careful perusal of these reports is invited, which will convey to your honorable body the full details of the plant and its operation.

We herewith submit the following items for your consideration. The secretary's report gives a full history of the work of this department. He adds to the itemized statement of the year's financial operations a summary of all receipts and disbursements from the time of the purchase of the works in 1882 to date; also, a number of comparative tables showing the growth of the works since the purchase.

NET COST OF WORKS TO DATE.

The original purchase	$510,000.00
Extension account (betterments in city)	2,080,396.85
Construction account (betterments outside of city)	1,365,035.18
Meters	100,355.29
	$4,055,767.32

Paid for as follows:

By bonds	$2,460,000.00
From surplus earnings of the works	1,595,767.32

The present bonded debt is $2,436,000, a decrease of $10,000. These bonds were purchased during the past year and cancelled.

The sinking fund now amounts to $693,135.52, an increase of $58,334.62 during the year, of which $689,165 is invested and $3,968.52 uninvested. Table No. 10 of the secretary's report gives a full history of this account. The annual interest on these invested funds amounts to $27,122.60.

There are now 5,593 meter accounts, an increase of 781 during the year. The total number of services is 17,913, an increase of 820. During the last year we have laid 19,507.8 feet of new mains and relaid 595 feet, making a total of 20,102.8 feet, or 3.8 miles. There are at present 251 miles and 3,329 feet of mains ranging from 4 inches to 36 inches in diameter, 2,346 fire hydrants, 2,202 valves and 333 street sprinkling hydrants.

One of the most important improvements made during the year was the construction of a new pumping station at Vadnais lake, in connection with the artesian well plant. This building, with an extra boiler and other improvements at this point, cost $10,495.88.

The rain fall during the year was 25.75 inches, a decrease of 8.47 inches from the year previous. This compelled the running of the pumping plants at Vadnais and Centerville stations for a longer period than usual, so as to maintain a good stage of water in Vadnais and Pleasant lakes for the winter supply. The increase of water pumped into this system over that of 1900 was 424,581,200 gallons from Centerville station and 182,209,400 gallons from artesian well plant at Vadnais lake.

The superintendent submits the following recommendations:

First—That a sixteen (16) inch main be laid on Maryland street from Cortland to McMenemy and a twelve (12) inch main on McMenemy from Maryland to Geranium street. This is for an additional supply for Arlington Hills and Dayton's Bluff.

Second—That the district bounded by Seventh, Broadway, Fourth and Kittson streets be rearranged by laying pipes on some of the streets that have none at present, and replacing pipes on some of the other streets with larger ones.

This section would have been rearranged some years ago, but was prevented by the old charter, which forbids the laying of mains without a petition of the property owners. The new charter provides that mains can be laid by vote of the common council upon request of the Board of Water Commissioners, without the petition of property owners.

We approve the above recommendations.

The average daily consumption of water during the past five years ending Dec. 31, 1901, has been as follows:

For the year 1897	7,322,200 gallons
For the year 1898	8,048,048 gallons
For the year 1899	8,337,207 gallons
For the year 1900	8,019,962 gallons
For the year 1901	8,026,435 gallons

ELECTROLYSIS.

We cannot too strongly call the attention of your honorable board to the importance of this subject to the welfare of the city's property. The damage already done is, in the opinion of this board, very great, and unless corrected promptly the result will be that the entire system of pipes and house connections will have to be renewed, the cost of which to the city, according to the board's estimate, would be some $2,000,000.

The board has had this matter under investigation since April, 1899, and a very lengthy and complete report was submitted by the city engineer to the board under date of Nov. 9, 1901. This report, together with the actions of this board in the past and the opinions of the corporation attorney, has been ordered printed and will be made a part of this report.

C. LIVINGSTON.
J. C. DONAHOWER.
JNO. J. DWYER,
THOS. GRACE.
JNO. M. CARLSON.

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1902.

is the largest number of services that has been put in since 1892. The total number of applications to date is 17,913, of which 10,801 are on high service and 7,112 on low service. There were 2,012 applications, all on low service, when the city purchased the works in 1882. Table No. 12 shows the number of applications made for water services annually, from 1869 to date.

PLUMBING AND INSPECTION. (See Table No. 18.)

Fifty-three plumbers were granted licenses during the year and 1,712 permits were issued to them to do work in connection with the introduction and extension of water services.

In addition to the inspection and examination of all the work done by licensed plumbers, there were 1,442 special inspections, of which 651 were on high service and 791 on low service. These special inspections were made, in the majority of cases, at the request of the consumers for change of rates.

General inspections of premises have also been made to the extent of 11,935. These general inspections are made every two years and are very valuable to the department. Each inspection reveals a number of extra fixtures which have been put in by plumbers since the last inspection and for which no permit was taken out nor report made. All leaks or imperfections discovered in these inspections are required to be repaired immediately by the occupants of the premises.

Table No. 18 shows the character and number of hose violations reported to this department during the past season; also, comparative statements for years 1894 to 1901 inclusive. This table also shows the number of permits issued annually to plumbers since 1884.

Respectfully submitted,

JOHN CAULFIELD,

Secretary.

TABLE No. 1.

TRIAL BALANCE TO JAN. 1, 1902.

	Dr.	Cr.
St. Paul water works (original purchase)....	$510,000.00	
Bond account		$2,436,000.00
General water receipts.....		2,923,779.01
Miscellaneous		334,925.61
Connection (services)	4,809.98	
Extension account	2,080,396.85	
General maintenance	605,444.42	
Repairs in city.....	70,347.85	
Meter account	100,355.29	
Construction	1,365,035.18	
Interest	1,862,034.90	
General water receipts (hydrant account)..		121,663.19
Sinking fund investments.....	689,165.00	
Sinking fund	3,968.52	
Sinking fund earnings.....		111,970.33
Shutting off and turning on water.....		2,450.00
Frontage tax		1,382,021.06
Bank of Minnesota.....	172.41	
City treasurer	16,772.48	
Repairs outside of city.....	5,217.42	
Rent account		911.10
	$7,313,720.30	$7,313,720.30

TABLE NO. 2.

RECEIPTS AND DISBURSEMENTS FOR YEAR 1901.

RECEIPTS.

Balance			$11,904.76
General water receipts, high service..	$55,363.98		
General water receipts, low service...	36,440.21		
General water receipts, meters.....	95,179.11		
		$186,983.30	
Miscellaneous receipts, builders.....	$1,186.09		
Miscellaneous receipts, flushing sewers	489.58		
Miscellaneous receipts, filling cisterns.	196.00		
Miscellaneous receipts, sprinkling strs.	15,885.74		
		17,757.41	
Connections—Services		20,602.18	
Shutting of and turning on water.....		67.00	
Extension		14,940.56	
Frontage tax.....		57,174.72	
Sinking fund earnings.....		24,417.60	
Sinking fund.....		16,082.98	
Meter		2,053.20	
Construction (new supply).....		2,005.29	
Rent account		323.50	
			342,407.74
Total receipts			$354,312.50

TABLE NO. 2—*Continued.*

DISBURSEMENTS.

General Maintenance—			
Salaries	$31,640.06		
Stationery and printing	1,949.15		
Miscellaneous	1,495.34		
Labor	3,157.17		
Material	8,051.15		
Stable—feed	400.53		
Stable—repairs	823.98		
		$47,517.38	
Connections—			
Labor	$13,597.52		
Pipe	5,618.43		
Brass goods and stop boxes	2,438.99		
Tools and miscellaneous	547.10		
		22,202.04	
Repairs—			
Hydrants—labor	$2,232.75		
Hydrants—material	43.14		
Valves—labor	348.76		
Valves—material	29.26		
Mains—labor	442.47		
Mains—material	32.65		
		3,127.03	
Meters—			
Labor and material	$6,226.68		
Freight and meters	6,126.26		
		12,352.94	
Extensions—			
Pipe and special castings	$14,440.67		
Labor and contracts	14,910.47		
Tools and repairs of same	476.30		
Advertising	47.10		
Fire hydrants	838.50		
Valves	787.23		
Lead and hemp packing	1,118.08		
Lumber and material	1,011.54		
Miscellaneous	451.49		
		34,087.38	
Construction—New Supply—			
Labor and contracts	$1,255.01		
Tools and repairs of same	24.75		
Lumber and material	86.62		
Engineering and right of way	1,528.15		
Miscellaneous and building account	10,163.35		
		13,057.88	
Interest	$113,550.00		
Refunded frontage tax	35.80		
Bond account	10,000.00		
Sinking fund	74,417.60		
Sinking fund earnings	6,082.98		
Repairs outside of city	936.58		
		205,022.96	
Total disbursements			337,367.61
Balance			$16,944.89

TABLE NO. 3.

RECEIPTS AND DISBURSEMENTS FROM AUG. 10, 1882, TO DEC. 31, 1901.

RECEIPTS.

General water receipts, high service..	$847,151.87		
General water receipts, low service...	1,070,150.02		
General water receipts, meters.....	1,006,477.12		
		$2,923,779.01	
Miscellaneous receipts, builders.....	$41,403.39		
Miscellaneous receipts, water carts...	3,796.13		
Miscellaneous receipts, flushing sewers	14,865.93		
Miscellaneous receipts, filling cisterns.	21,551.59		
Miscellaneous receipts, sprinkling strs.	253,308.57		
		334,925.61	
Connections—Services		360,958.73	
Shutting off and turning on water.....		2,450.00	
Extension		51,807.51	
Interest		67,964.84	
Frontage tax.....		1,385,301.04	
Sinking fund earnings.....		160,594.92	
Sinking fund.....		65,624.59	
Meter		6,503.88	
Construction account.....		8,299.63	
Repair		3,319.85	
Bills payable.....		653,000.00	
Bonds		2,110,000.00	
General water receipts, hydrant acc't.		121,663.19	
Rent account.....		911.10	
			$8,257,103.90
Total receipts			$8,257,103.90

DISBURSEMENTS.

General Maintenance—			
Salaries	$343,988.79		
Stationery and printing.....	24,177.37		
Miscellaneous	14,873.00		
Labor	79,851.68		
Material	129,336.26		
Stable—feed	7,167.76		
Stable—repairs	6,049.56		
		$605,444.42	
Connections—			
Labor	$211,353.69		
Pipe	95,906.96		
Brass goods and stop boxes.....	48,207.28		
Tools and miscellaneous.....	10,100.78		
		365,768.71	
Repairs—			
Hydrants—labor	$45,658.97		
Hydrants—material	2,166.31		
Valves—labor	3,272.91		
Valves—material	740.94		
Mains—labor	19,134.12		
Mains—material	2,694.45		
		73,667.70	
Meters—			
Labor and material.....	$38,202.16		
Freight and meters.....	68,657.01		
		106,859.17	
Extensions—			
Pipe and special castings.....	$1,109,513.00		
Labor and contracts.....	686,272.74		
Tools and repairs of same.....	20,933.33		
Advertising	534.36		
Fire hydrants	101,480.34		
Valves	83,056.24		
Lead and hemp packing.....	70,663.61		
Lumber and material.....	27,325.09		
Miscellaneous	32,425.65		
		2,132,204.36	

TABLE NO. 3—*Continued.*

Construction—New Supply—			
Pipe and special castings	$190,423.50		
Labor and contracts	729,076.52		
Tools and repairs of same	7,555.50		
Lumber and material	99,992.86		
Freight	9,734.03		
Engineering and right of way	155,589.71		
Miscellaneous and building account	32,115.24		
Reservoirs	148,847.45		
		1,373,334.81	
Interest	$1,929,999.74		
Refunded frontage tax	3,279.98		
Bills payable	653,000.00		
Sinking fund	758,758.11		
Sinking fund earnings	48,624.59		
Bond account	184,000.00		
Repairs outside of city	5,217.42		
		3,582,879.84	
Total disbursements			$5,240,159.01
Balance			$16,944.89

TABLE NO. 4.

STATEMENT SHOWING AMOUNT PAID THE CITY TREASURER, FROM JAN. 1, 1901, TO DEC. 31, 1901.

January 1.	Balance in treasury as per last report		$11,701.01
January.	Cash	$24,144.95	
February.	Cash	16,468.37	
March.	Cash	32,021.61	
April.	Cash	13,853.59	
May.	Cash	15,253.14	
June.	Cash	39,317.26	
July.	Cash	50,870.14	
August.	Cash	20,877.17	
September.	Cash	40,223.32	
October.	Cash	15,196.71	
November.	Cash	20,353.25	
December.	Cash	13,358.99	
			301,938.50
Total			$313,639.51

TABLE NO. 5.

WARRANTS DRAWN ON CITY TREASURER FROM JAN. 1, 1901, TO DEC. 31, 1901, INCLUSIVE.

Jan. 1.	Warrant Nos. 11652 to 11662 inclusive	$15,303.15		
Jan. 12.	Warrant Nos. 11663 to 11690 inclusive	471.28		
			$15,774.43	
Feb. 1.	Warrant Nos. 11691 to 11703 inclusive	$11,228.33		
Feb. 8.	Warrant Nos. 11704 to 11734 inclusive	420.37		
			11,648.70	
Mar. 1.	Warrant Nos. 11735 to 11749 inclusive	$5,360.80		
Mar. 8.	Warrant Nos. 11750 to 11779 inclusive	26,389.48		
Mar. 9.	Warrant Nos. 11780 to 11786 inclusive	3,588.51		
			35,338.79	
April 1.	Warrant Nos. 11787 to 11793 inclusive	$4,649.15		
April 11.	Warrant Nos. 11794 to 11832 inclusive	10,746.74		
			15,395.89	
May 1.	Warrant Nos. 11833 to 11853 inclusive	$14,659.95		
May 10.	Warrant Nos. 11854 to 11899 inclusive	1,689.80		
May 14.	Warrant No. 11900	125.00		
			16,474.75	
June 1.	Warrant Nos. 11901 to 11914 inclusive	$12,604.88		
June 11.	Warrant Nos. 11915 to 11961 inclusive	1,315.70		
			13,920.58	

TABLE NO. 5—*Continued.*

July	1.	Warrant Nos. 11962 to 11976 inclusive	$35,748.25		
July	12.	Warrant Nos. 11977 to 12019 inclusive	1,642.48		
				37,390.73	
Aug.	3.	Warrant Nos. 12020 to 12041 inclusive	$30,442.60		
Aug.	10.	Warrant Nos. 12042 to 12091 inclusive	8,624.47		
				39,067.07	
Sept.	2.	Warrant Nos. 12092 to 12110 inclusive	$38,392.91		
Sept.	12.	Warrant Nos. 12111 to 12153 inclusive	1,441.30		
Sept.	16.	Warrant No. 12154.....	62.50		
				39,896.71	
Oct.	2.	Warrant Nos. 12155 to 12181 inclusive	$24,234.65		
Oct.	10.	Warrant Nos. 12182 to 12223 inclusive	1,921.89		
				26,156.54	
Nov.	1.	Warrant Nos. 12224 to 12240 inclusive	$15,957.90		
Nov.	2.	Warrant Nos. 12241 to 12253 inclusive	14,115.23		
Nov.	11.	Warrant Nos. 12254 to 12298 inclusive	1,896.67		
Nov.	19.	Warrant No. 12299.....	4,348.25		
				36,318.05	
Dec.	2.	Warrant Nos. 12300 to 12316 inclusive	$7,690.39		
Dec.	12.	Warrant Nos. 12317 to 12360 inclusive	1,794.40		
				9,484.79	
					$206,867.03

TABLE NO. 6.

CONTRACTS MADE BY THE BOARD OF WATER COMMISSIONERS FROM JAN. 1, 1901, TO DEC. 31, 1901.

No.	Date.	With Whom and for What Purpose.	Amount of Contract.	Amount Paid.
1.	Jan. ...	Pioneer Press Co., printing annual report for 1900	$326.25	$326.25
2.	Jan. 12.	Jos. Lamotte, cutting wood and piles at Centerville	1,147.85	1,147.85
3.	Mar. 5.	Western Supply Co., lead pipe	2,497.46	2,497.46
4.	Mar. 5.	Crane & Ordway Co., corporation taps, stop and waste cocks	543.48	543.48
5.	Mar. 5.	Bingham & Taylor, valve and service boxes	1,964.33	1,964.33
6.	Mar. 5.	South Park Foundry & Machine Co., special castings	729.84	729.84
7.	Mar. 5.	Pittsburg Meter Co., water meters.....	4,221.37	4,221.37
8.	May 17.	The Western Supply Co., pig lead.....	764.50	764.50
9.	May 16.	South Park Foundry & Machine Co., fire hydrants	838.50	838.50
10.	May 16.	U. S. Cast Iron Pipe & Foundry Co., cast iron pipe	10,666.82	10,666.82
11.	May 17.	R. D. Wood & Co., water gates.....	442.85	442.85
12.	May 16.	James Shiely, drayage.....	252.80	252.80
13.	July 29.	Wm. F. Porten, pumping station, Vadnais Lake	8,645.00	8,645.00
14.	Aug. 31.	Crane & Ordway Co., lead pipe.....	2,103.99	2,103.99
15.	Aug. 31.	John Kenny, boiler, Vadnais Lake station	449.50	449.50
16.	Sept. 12.	J. B. Clow & Sons, cast iron pipe.....	2,791.86	2,791.86
			$38,386.40	$38,386.40

TABLE NO. 6—Continued.

CONTRACTS MADE PREVIOUS TO DEC. 31, 1900, AND FOR WHICH FINAL SETTLEMENT WAS NOT MADE AT TIME OF LAST REPORT.

Date.	With Whom and for What Purpose.	Am't Due Dec. 31, 1900.	Amount Paid.
Feb. 3, 1900.	Pittsburg Meter Co., meters.....	$784.00	$784.00
May 1, 1900.	Patrick Doherty, laying and relaying water pipes	711.71	711.71
May 1, 1900.	Chris. Johnson, laying water pipes.....	220.60	220.60
July 10, 1900.	F. L. Gregory, coal and wood.....	5,268.42	5,268.42
		$6,984.73	$6,984.73

TABLE

BOND ACCOUNT

Date of Legislative Act Authorizing Issue of Bonds.	Amount of Bonds Authorized.	Date of Bonds Issued.	When Due.	Amount of Bonds Issued.	Rate.	Amount Purchased and Canceled	Amount Due.
Feb. 10, 1881	$600,000	June 1, 1882	June 1, 1912	$350,000 00	4%	.....	$350,000.00
		Aug. 1, 1883	Aug. 1, 1913	150,000.00	5%	$2,000.00	148,000.00
		Apr. 1, 1884	Apr. 1, 1914	100,000.00	5%	.....	100,000.00
Jan. 26, 1883	500,000	Apr. 1, 1884	Apr. 1, 1909	500,000.00	5%	8,000.00	492,000.00
Feb. 21, 1885	800,000	Apr. 1, 1885	Apr. 1, 1915	400,000.00	5%	.....	400,000.00
Jan. 31, 1887	200,000	May 2, 1887	May 2, 1917	200,000.00	4½%	.....	200,000.00
Jan. 31, 1887	160,000	Mar. 1, 1888	Mar. 1, 1918	300,000.00	4½%	.....	300,000.00
		Jan. 1, 1889	Jan. 1, 1919	100,000.00	4½%	2,000.00	98,000.00
		Jan. 2, 1889	Jan. 2, 1919	160,000.00	4½%	12,000.00	148,000.00
Mar. 29, 1889	300,000	May 1, 1889	May 1, 1919	100,000.00	4½%	.....	100,000.00
		May 1, 1890	May 1, 1920	100,000.00	4%	.....	100,000.00
				$2,460,000.00	.....	$24,000.00	$2,436,000.00

STATEMENT OF CITY BONDS ISSUED FOR WATER WORKS

When Purchased.	Date of Issue.	When Due.	Rate of Interest.
March 15, 1900.....	April 1, 1884.....	April 1, 1909.....	5 per cent
March 27, 1900.....	Aug. 1, 1888.....	Aug. 1, 1918.....	5 per cent
March 27, 1900.....	Jan. 2, 1889.....	Jan. 2, 1919.....	4½ per cent
Oct. 20, 1900.....	Jan. 2, 1889.....	Jan. 2, 1919.....	4½ per cent
Dec. 18, 1900.....	Jan. 1, 1889.....	Jan. 1, 1919.....	4½ per cent
Aug. 22, 1901.....	Jan. 2, 1889.....	Jan. 2, 1919.....	4½ per cent
Aug. 22, 1901.....	Jan. 1, 1889.....	Jan. 1, 1919.....	4½ per cent
Nov. 18, 1901.....	April 1, 1884.....	April 1, 1909.....	5 per cent
Total.....	.....	.....	.....

Amount of annul interest saved by the purchase of the above bonds, $1,180.00.

NO. 7.

JANUARY 1, 1902.

Interest Payable.												Total Annual Interest.
Dec. 1.	Jan. 2.	Feb. 1.	Mar. 2.	Apr. 1.	May 2.	June 1.	July 2.	Aug. 1.	Sept. 1.	Oct. 1.	Nov. 2.	
$7,000	.....	.....	.....	.....	.....	$7,000	.....	.....	.....	.....	.....	$14,000.00
.....	.....	$3,700	.....	.....	.....	.....	.....	$3,700	.....	.....	.....	7,400.00
.....	.....	.....	.....	$2,500	.....	.....	.....	.....	.....	$2,500	.....	5,000.00
.....	.....	.....	.....	12,300	.....	.....	.....	.....	.....	12,300	.....	24,600.00
.....	.....	.....	.....	10,000	.....	.....	.....	.....	.....	10,000	.....	20,000.00
.....	.....	.....	.....	.....	$4,500	.....	.....	.....	.....	.....	$4,500	9,000.00
.....	.....	.....	$6,750	.....	.....	.....	.....	.....	$6,750	.....	.....	13,500.00
.....	$2,205	.....	.....	.....	.....	.....	$2,205	.....	.....	.....	.....	4,410.00
.....	3,330	.....	.....	.....	.....	.....	3,330	.....	.....	.....	.....	6,660.00
.....	.....	.....	.....	.....	2,250	.....	.....	.....	.....	.....	2,250	4,500.00
.....	.....	.....	.....	.....	2,000	.....	.....	.....	.....	.....	2,000	4,000.00
$7,000	$5,535	$3,700	$6,750	$24,800	$8,750	$7,000	$5,535	$3,700	$6,750	$24,800	$8,750	$113,070.00

PURPOSES, PURCHASED AND CANCELED IN 1900 AND 1901.

No.	Amount Purchased.	Premium Paid.		Accrued Interest.	Total Paid.	From What Fund.	
		Rate.	Amount.			Surplus Earnings.	Sinking Fund.
2	$2,000.00	113.98	$279.60	$45.48	$2,325.08	$2,325.08	.....
2	2,000 00	120.81	406.20	15.07	2,421.27	2,421.27	.....
3	3,000.00	119.40	582.00	31.44	3,613.44	3,613.44	.....
6	6,000.00	118.98	1,135.80	80.25	7,216.05	....	$7,216.05
1	1,000.00	118.89	188.90	18.37	1,207.27	.....	1,207.27
3	3,000.00	118.83	549.90	18.50	3,568.40	.....	3,568.40
1	1,000.00	118.83	188.30	6.16	1,189.46	.....	1,189.46
6	6,000.00	112.33	739.80	32.05	6,771.85	.....	6,771.85
....	$24,000.00	.....	$4,065.50	$247.32	$28,312.82	$8,359.79	$19,953.08

TABLE NO. 8.

STATEMENT SHOWING AMOUNT DUE THE BOARD OF WATER COMMISSIONERS ON DEC. 31, 1901, FROM CITY OF ST. PAUL.

Water for fire purposes from Dec. 1, 1891, to June 1, 1892.	$28,401.53	
Water for fire purposes from June 1, 1892, to Dec. 1, 1892	29,229.79	
Water for fire purposes from Dec. 1, 1892, to June 1, 1893	30,546.89	
Water for fire purposes from June 1, 1893, to Dec. 1, 1893	31,607.77	
Water for fire purposes from Dec. 1, 1893, to June 1, 1894.	31,773.12	
Water for fire purposes from June 1, 1894, to Dec. 1, 1894.	32,307.00	
Water for fire purposes from Dec. 1, 1894, to June 1, 1895	32,700.16	
Water for fire purposes from June 1, 1895, to Dec. 1, 1895	33,204.95	
Water for fire purposes from Dec. 1, 1895, to June, 1 1896	33,341.84	
Water for fire purposes from June 1, 1896, to Dec. 1, 1896.	33,509.57	
Water for fire purposes from Dec. 1, 1896, to June 1, 1897	33,663.27	
Water for fire purposes from June 1, 1897, to Dec. 1, 1897	33,823.91	
Water for fire purposes from Dec. 1, 1897, to June 1, 1898	33,978.33	
Water for fire purposes from June 1, 1898, to Dec. 1, 1898	34,184.94	
Water for fire purposes from Dec. 1, 1898, to June 1, 1899	34,325.95	
Water for fire purposes from June 1, 1899, to Dec. 1, 1899	34,571.36	
Water for fire purposes from Dec. 1, 1899, to June 1, 1900	34,740.08	
Water for fire purposes from June 1, 1900, to Dec. 1, 1900	35,029.27	
Water for fire purposes from Dec. 1, 1900, to June 1, 1901	35,251.69	
Water for fire purposes from June 1, 1901, to Dec. 1, 1901	35,490.95	
		$661,682.37
Premiums received and retained by city on $160,000 of bonds issued in January, 1889, to redeem the bonds of the old St. Paul Water Co. of like amount assumed by the city at the time of the purchase of the works		5,393.77

TABLE NO. 8—*Continued.*

Relaying of water mains caused by change of grade—			
On Mt. Airy, between Valley and Warren.....	$248.12		
On Fairview, between Jackson and Mt. Airy.	134.25		
On East Sixth, between Maria and Hoffman..	399.75		
On East Sixth, between Broadway and Olive..	674.37		
On Flandrau, at Harvester.....	65.00		
Changing main at Como bridge.....	760.58		
Lowering main on Grand avenue.....	94.00		
Raising main Cedar and Fifth.....	202.15		
		2,578.22	
For repairing sprinkling hydrants.....	$117.75		
For water for flushing sewers, 1901.....	72.12		
		189.87	
For water for public hydrant, corner Fillmore and Eva, Register No. 705.....	$2.17		
For water for public hydrant, corner State and Indiana, Register No. 706.....	62.70		
		64.87	
			$669,909.10
From Board of Education—			
Schools from May 1, 1898, to July 1, 1900.....		$6,876.35	
Schools from Sept. 1, 1901, to Jan. 1, 1902.....		1,085.41	
			7,961.76
Balance frontage tax assessment for 1896 and prior		$17,654.05	
Balance frontage tax assessment for 1897.....		6,348.10	
Balance frontage tax assessment for 1898.....		6,803.28	
Balance frontage tax assessment for 1899.....		2,222.58	
Balance frontage tax assessment for 1900.....		10,570.34	
For frontage tax assessment for 1901.....		40,532.23	
			84,131.30
From builders		$100.00	
Union Depot Co.....		741.64	
Putting in 4-inch services.....		178.07	
			1,019.71
Total			$763,021.87

TABLE NO. 9.

FRONTAGE TAX ACCOUNT, COLLECTIONS—BALANCE DUE JAN. 1, 1902.

Receipts for Year 1901.	1896 and Prior.	1897.	1898.	1899.	1900.	1901.	Total.
January 8				$1,125.00			$1,125.00
February 6				2,200.00	$500.00		2,700.00
June 29	$616.99	$119.95	$112.91	389.92	18,760.23		20,000.00
July 30	91.05	121.74	128.03	4,314.90	16,758.39		21,414.11
August 3					875.00		875.00
September 12				230.00	300.00		530.00
October 12					1,100.00		1,100.00
November 26	919.75	159.47	172.36	100.16	7,518.87		8,930.61
December 5					500.00		500.00
Total receipts	$1,627.79	$401.16	$413.30	$8,419.98	$46,312.49		$57,174.72
Amount due Jan. 1, 1901, as per last report	19,281.84	6,749.26	7,216.58	10,642.56	56,882.83		100,773.07
							$43,598.35
Amount of 1901 assessment collectible in 1902						$40,532.23	40,532.95
Amount due Jan. 1, 1902	$17,654.05	$6,348.10	$6,803.28	$2,222.58	$10,570.34		$84,131.30

TABLE NO. 11.

Month.	Pay Roll for Year, Including Salaries of Officers, Engineers, Firemen, Inspectors and Laborers.		Salaries of Engineers, Firemen and Keepers at the Various Stations.						
	Number of Men.	Total Amount of Pay Roll.	McCarron Lake Station.	Vadnais Lake Station.	Baldwin Lake Station.	West St. Paul Station.	Centerville Station.	Reservoir.	Total.
December, 1900..	84	$4,180.45	$435.00	$50.00	$10.00	$115.00	$50.00	$40.00	$700.00
January, 1901....	80	4,079.41	435.00	50.00	10.00	115.00	50.00	40.00	700.00
February, 1901...	84	4,391.99	435.00	50.00	10.00	115.00	50.00	40.00	700.00
March, 1901.....	92	4,413.24	435.00	50.00	10.00	115.00	50.00	40.00	700.00
April, 1901.....	105	4,996.53	435.00	50.00	10.00	115.00	50.00	40.00	700.00
May, 1901.....	114	5,881.48	435.00	50.00	10.00	115.00	50.00	40.00	700.00
June, 1901.....	148	6,337.28	435.00	50.00	10.00	115.00	50.00	40.00	700.00
July, 1901.....	183	7,805.36	435.00	78.00	10.00	115.00	50.00	40.00	728.00
August, 1901.....	170	8,417.21	435.00	106.00	10.00	115.00	165.00	40.00	871.00
September, 1901..	139	6,859.67	435.00	110.00	10.00	115.00	165.00	40.00	875.00
October, 1901....	138	7,526.47	435.00	110.00	10.00	115.00	165.00	40.00	875.00
November, 1901..	129	6,287.48	435.00	64.00	10.00	115.00	107.50	40.00	771.50
Totals	1,466	71,176.57	5,220.00	818.00	120.00	1,380.00	1,002.50	480.00	9,020.50

TABLE NO. 12.

THE FOLLOWING TABLE SHOWS THE NUMBER OF APPLICATIONS MADE FOR WATER SERVICE ANNUALLY FROM 1869 TO DATE.

Year.	High Service.	Low Service.	Total.
1869	.....	34	
1870	.....	321	
1871	.....	250	
1872	.....	164	
1873	.....	131	
1874	.....	153	
1875	.....	95	
1876	.....	85	
1877	.....	67	
1878	.....	50	
1879	.....	180	
1880	.....	167	
1881	.....	164	
1882	.....	264	
1883	.....	301	
			2,426
1884	164	336	500
1885	644	365	1,009
1886	639	369	1,008
1887	747	325	1,072
1888	812	406	1,218
1889	1,327	491	1,818
1890	1,071	336	1,407
1891	811	264	1,075
1892	671	210	881
1893	474	151	625
1894	363	139	502
1895	390	311	701
1896	384	156	540
1897	332	98	430
1898	401	129	530
1899	503	163	666
1900	480	205	685
1901	588	232	820
	10,801	7,112	17,913

TABLE NO. 13.

PUMPING PLANTS—EXPENSE MAINTAINING THE FIVE (5) PUMPING STATIONS AND RESERVOIR.

Station.	Salaries.	Fuel.	Waste and Machine Oil.	Supplies and Repairs.	Kerosene Oil.	Total.
McCarron lake...	$5,220.00	$4,627.95	$270.37	$255.43	$3.92	$10,377.67
Baldwin lake.....	120.00	55.00	.....	30.62	.....	205.62
Vadnais lake.....	818.00	625.73	38.30	21.04	17.16	1,520.23
West St. Paul....	1,380.00	561.36	.....	79.90	19.88	2,041.14
Centerville	1,002.50	1,129.05	26.30	47.76	19.48	2,225.09
Reservoir	480.00	.....	.....	.....	.....	480.00
Totals	$9,020.50	$6,999.09	$334.97	$434.75	$60.44	$16,849.75

TABLE NO. 14.

METERS IN SERVICE JAN. 1, 1902.

Kind of Meters.	Size.									Total
	½	⅝	¾	1	1½	2	3	4	6	
Worthington (improved)...	.....	94	97	35	39	7	4	2	....	278
Worthington (old style)...	.....	5	14	7	9	2	.....	.....	....	37
Union (rotary).....	.....	64	21	10	24	1	1	2	1	124
Columbia	.....	9	.....	.....	.....	.....	.....	.....	.....	9
Nash	.....	10	2	1	.....	.....	.....	.....	....	13
Nash "A".....	.....	15	1	.....	.....	.....	.....	.....	....	16
Nash "AA".....	.....	60	.....	.....	.....	.....	.....	.....	....	60
Nash "AX".....	.....	.....	.....	.....	1	.....	.....	.....	....	1
Crown	.....	67	13	25	33	9	1	2	....	150
Crown "A".....	.....	1	3	1	.....	.....	.....	.....	....	5
Crown "AA".....	.....	539	....	12	3	1	.....	.....	....	555
Empire	9	15	39	33	.....	6	.....	1	....	103
Empire "A".....	.....	6	3	3	.....	.....	.....	.....	....	12
Empire "AA".....	.....	1	2	.....	.....	.....	.....	.....	....	3
Empire "AAX".....	.....	6	3	1	.....	.....	.....	.....	....	10
Gem	.....	.....	.....	.....	.....	.....	1	1	....	2
Gem "AA".....	.....	.....	.....	.....	.....	.....	.....	1	1	2
Thomson	.....	12	2	.....	.....	.....	.....	.....	....	14
Thomson "B".....	2	44	14	3	2	2	.....	1	....	68
Lambert	.....	9	1	1	.....	.....	.....	.....	....	11
Lambert "A".....	.....	1	1	.....	.....	.....	.....	.....	....	2
Hersey	.....	34	35	29	23	13	2	1	....	137
Hersey Disc.....	.....	1	.....	.....	2	2	.....	.....	....	5
Frost	.....	.....	1	.....	.....	.....	.....	.....	....	1
Trident	.....	61	1	1	.....	.....	.....	.....	....	63
Westinghouse	.....	3	....	5	1	1	.....	.....	....	10
Pittsburg Disc.....	.....	3,244	53	72	32	15	1	.....	....	3,417
Niagara	.....	294	8	5	1	1	.....	.....	....	309
Totals	11	4,595	314	244	170	60	10	11	2	5,417

TABLE NO. 15.

SHUTTING OFF AND TURNING ON WATER FROM JAN. 1, 1901, TO JAN. 1, 1902.

	High Service.	Low Service.	Total.
Shut off for repairs	281	298	579
Shut off for non-payment	133	125	258
Shut off for vacant premises	494	285	779
Shut off for violation of rules	6	4	10
Totals	914	712	1,626
Turned on old services	897	653	1,550
Turned on new services	567	204	771
Turned on for builders	.....	41	41
Totals	1,464	898	2,362

Total services shut off and turned on for year ending:

December 1, 1884	1,014	December 1, 1893	4,477
December 1, 1885	2,311	December 1, 1894	4,932
December 1, 1886	2,384	December 1, 1895	4,606
December 1, 1887	2,541	December 31, 1896	4,373
December 1, 1888	2,833	December 31, 1897	4,435
December 1, 1889	3,978	December 31, 1898	4,170
December 1, 1890	3,919	December 31, 1899	4,697
December 1, 1891	4,743	December 31, 1900	3,979
December 1, 1892	4,470	December 31, 1901	3,988

TABLE NO. 16.

SHOWING THE DIFFERENT KINDS AND SIZES OF METERS BELONGING TO THE CITY AND PRIVATE PARTIES, IN SERVICE AND ON HAND, DEC. 31, 1901.

Kind of Meters.	Size in Inches.	Property of City.			Private Property.			Grand Total of Meters in Service.	Grand Total of Meters in Shop.	Grand Total of All Meters.
		In Service.	At Work Shop.	Total.	In Service.	At Work Shop.	Total.			
Columbia	5/8	9	3	12	....	....	....	9	3	12
Crown	4	1	....	1	1	....	1	2	....	2
Crown	3	1	....	1	....	....	....	1	....	1
Crown	2	8	1	9	1	....	1	9	1	10
Crown	1½	33	....	33	....	....	....	33	....	33
Crown	1	25	....	25	....	....	....	25	....	25
Crown	¾	13	....	13	....	....	....	13	....	13
Crown	5/8	65	1	66	2	....	2	67	1	68
Crown	3/8	.....	1	1	....	....	....	.....	1	1
Crown "A"	1	1	....	1	....	....	....	1	....	1
Crown "A"	¾	3	2	5	....	....	....	3	2	5
Crown "A"	5/8	1	2	3	....	....	....	1	2	3
Crown "AA"	2	.....	.....	.....	1	....	1	1	....	1
Crown "AA"	1½	3	....	3	....	....	....	3	....	3
Crown "AA"	1	12	1	13	....	....	....	12	1	13
Crown "AA"	5/8	538	11	549	1	....	1	539	11	550
Empire	4	1	....	1	....	....	....	1	....	1
Empire	2	6	4	10	....	....	....	6	4	10
Empire	1	33	1	34	....	....	....	33	1	34
Empire	¾	39	....	39	....	....	....	39	....	39
Empire	5/8	14	....	14	1	....	1	15	....	15
Empire	½	9	....	9	....	....	....	9	....	9
Empire "A"	1	3	....	3	....	....	....	3	....	3
Empire "A"	¾	3	....	3	....	....	....	3	....	3
Empire "A"	5/8	6	....	6	....	....	....	6	....	6
Empire "AA"	¾	2	....	2	....	....	....	2	....	2
Empire "AA"	5/8	1	....	1	....	....	....	1	....	1
Empire "AAX"	1	1	....	1	....	....	....	1	....	1
Empire "AAX"	¾	3	....	3	....	....	....	3	....	3
Empire "AAX"	5/8	6	....	6	....	....	....	6	....	6
Frost	¾	1	....	1	....	....	....	1	....	1
Gem	4	.....	.....	.....	1	....	1	1	....	1
Gem	3	.....	.....	.....	1	....	1	1	....	1
Gem "AA"	6	.....	.....	.....	1	....	1	1	....	1
Gem "AA"	4	.....	.....	.....	1	....	1	1	....	1
Hersey	4	.....	.....	.....	1	....	1	1	....	1
Hersey	3	2	....	2	....	....	....	2	....	2
Hersey	2	13	....	13	....	....	....	13	....	13
Hersey	1½	23	....	23	....	....	....	23	....	23
Hersey	1	29	1	30	....	....	....	29	1	30
Hersey	¾	35	1	36	....	....	....	35	1	36
Hersey	5/8	34	....	34	....	....	....	34	....	34
Hersey disc	2	2	....	2	....	....	....	2	....	2
Hersey disc	1½	2	....	2	....	....	....	2	....	2
Hersey disc	5/8	1	1	2	....	....	....	1	1	2
Lambert	1	1	....	1	....	....	....	1	....	1
Lambert	¾	1	....	1	....	....	....	1	....	1
Lambert	5/8	9	....	9	....	....	....	9	....	9
Lambert "A"	¾	1	....	1	....	....	....	1	....	1
Lambert "A"	5/8	1	....	1	....	....	....	1	....	1
Nash	1	.....	.....	.....	1	....	1	1	....	1
Nash	¾	2	....	2	....	....	....	2	....	2
Nash	5/8	9	1	10	1	1	2	10	2	12
Nash "A"	¾	1	....	1	....	....	....	1	....	1
Nash "A"	5/8	14	....	14	1	....	1	15	....	15
Nash "AA"	5/8	60	....	60	....	....	....	60	....	60
Nash "AX"	1½	.....	.....	.....	1	....	1	1	....	1
Niagara	2	.....	.....	.....	1	1	2	1	1	2

TABLE NO. 16—*Continued.*

Kind of Meters.	Size in Inches.	Property of City.			Private Property.			Grand Total of Meters in Service.	Grand Total of Meters in Shop.	Grand Total of All Meters.
		In Service.	At Work Shop.	Total.	In Service.	At Work Shop.	Total.			
Niagara	1½	.....	....	.....	1	....	1	1	....	1
Niagara	1	.....	....	.....	5	....	5	5	....	5
Niagara	¾	.....	....	.....	8	....	8	8	....	8
Niagara	⅝	291	9	300	3	....	3	294	9	303
Pittsburg disc	3	1	....	1	....	....	....	1	....	1
Pittsburg disc	2	15	1	16	....	....	....	15	1	16
Pittsburg disc	1½	32	....	32	....	....	....	32	....	32
Pittsburg disc	1	72	7	79	....	....	....	72	7	79
Pittsburg disc	¾	53	2	55	....	....	....	53	2	55
Pittsburg disc	⅝	3,241	161	3,402	3	....	3	3,244	161	3,405
Thomson	¾	2	....	2	....	....	....	2	....	2
Thomson	⅝	12	....	12	....	....	....	12	....	12
Thomson "B"	4	.....	....	.....	1	....	1	1	....	1
Thomson "B"	2	1	....	1	1	....	1	2	....	2
Thomson "B"	1½	2	....	2	....	....	....	2	....	2
Thomson "B"	1	3	....	3	....	....	....	3	....	3
Thomson "B"	¾	13	1	14	1	....	1	14	1	15
Thomson "B"	⅝	44	1	45	....	....	....	44	1	45
Thomson "B"	½	2	1	3	....	....	....	2	1	3
Trident	1	1	....	1	....	....	....	1	....	1
Trident	¾	1	....	1	....	....	....	1	....	1
Trident	⅝	61	2	63	....	....	....	61	2	63
Union rotary	6	.....	....	.....	1	....	1	1	....	1
Union rotary	4	2	....	2	....	....	....	2	....	2
Union rotary	3	1	....	1	....	....	....	1	....	1
Union rotary	2	1	2	3	....	....	....	1	2	3
Union rotary	1½	23	2	25	1	....	1	24	2	26
Union rotary	1	10	2	12	....	....	....	10	2	12
Union rotary	¾	21	....	21	....	....	....	21	....	21
Union rotary	⅝	64	4	68	....	....	....	64	4	68
Westinghouse	2	1	....	1	....	....	....	1	....	1
Westinghouse	1½	1	....	1	....	....	....	1	....	1
Westinghouse	1	5	....	5	....	....	....	5	....	5
Westinghouse	⅝	3	....	3	....	....	....	3	....	3
Worthington improved	4	.....	....	.....	2	....	2	2	....	2
Worthington improved	3	.....	....	.....	4	....	4	4	....	4
Worthington improved	2	2	....	2	5	....	5	7	....	7
Worthington improved	1½	35	1	36	4	....	4	39	1	40
Worthington improved	1	33	....	33	2	....	2	35	....	35
Worthington improved	¾	94	6	100	3	....	3	97	6	103
Worthington improved	⅝	74	5	79	20	....	20	94	5	99
Worthington old style	3	.....	3	3	....	....	....	.....	3	3
Worthington old style	2	2	....	2	....	....	....	2	....	2
Worthington old style	1½	9	....	9	....	....	....	9	....	9
Worthington old style	1	7	....	7	....	....	....	7	....	7
Worthington old style	¾	14	....	14	....	....	....	14	....	14
Worthington old style	⅝	5	....	5	....	....	....	5	....	5
		5,335	241	5,576	82	2	84	5,417	243	5,660

TABLE NO. 17.

EXPENSE FOR MAINTAINING PUMPING STATIONS AND RESERVOIR FOR YEARS 1891-2-3-4-5-6-7-8-9-1900-1901.

McCARRON LAKE STATION.

Year.	Salaries.	Fuel.	Machine Oil and Waste.	Repairs and Supplies.	Kerosene Oil.	Total.	Water Pumped.		Fuel, Coal, Etc.		Daily Increase in Pumping Gallons.
							Annually.	Daily.	Annually.	Daily.	
1891	$3,540.00	$4,702.12	$213.86	$230.66	$38.50	$8,725.14	1,106,034,800	3,030,232	2,134,000	5,845	871,090
1892	3,575.00	5,400.89	302.36	37.82	36.75	9,352.82	1,071,130,320	2,934,603	2,036,734	5,580	.....
1893	3,593.00	5,413.30	279.56	329.46	Electric.	9,615.32	1,298,551,200	3,557,674	2,147,888	5,884	623,070
1894	3,706.50	5,012.85	237.99	351.12	5.20	9,313.66	1,300,813,800	3,882,110	2,345,731	6,427	326,000
1895	3,652.00	5,034.79	243.57	269.09	5.20	9,204.65	1,536,912,600	4,210,719	2,536,020	6,948	338,609
1896 (13 months).	3,747.00	5,963.64	292.40	305.74	.....	10,308.78	1,651,524,200	4,160,011	2,751,698	6,915	*50,708
1897	3,600.00	3,888.07	237.45	101.68	.....	7,827.20	1,280,312,340	3,507,705	2,074,208	5,682	*652,306
1898	3,754.50	2,923.00	293.34	83.14	4.72	7,058.70	1,456,168,200	3,989,501	2,205,128	5,992	482,301
1899	5,480.16	3,845.45	254.76	318.09	4.77	9,903.23	1,458,679,700	3,999,122	2,149,470	5,893	10,112
1900	5,168.34	4,307.46	320.24	334.99	.....	10,131.03	1,447,107,400	3,964,677	2,127,807	5,829	*34,445
1901	5,220.00	4,627.95	270.37	255.43	3.92	10,377.67	1,416,118,500	3,879,776	2,124,125	5,819	*84,901

*Decrease.

BALDWIN LAKE STATION.

1891	$1,507.16	$4,998.44	$51.98	$77.39	$22.14	$6,657.11	1,983,034,500	8,077,585	Wood 797¾ Coal 150,325	.....	.....
1892	1,062.08	941.00	56.28	56.12	11.90	2,127.39	1,153,794,000	9,470,266	Wood 576	.....	.....
1893	1,145.66	778.42	45.18	363.99	10.35	2,343.60	1,104,158,600	9,219,623	Wood 461¾	.....	.....
1894	1,245.66	1,182.05	49.80	251.63	10.30	2,739.44	1,449,360,900	9,662,406	Wood 666½	4½	.....
1895	1,450.00	2,524.46	23.77	45.19	27.08	4,070.50	1,914,949,800	8,824,653	Wood 821	4	.....
1896 (13 months).	1,564.70	1,697.88	17.88	14.40	15.93	3,310.79	1,917,058,000	9,271,715	Wood 841¾	4.3	.....
1897	35.00	.....	.....	.....	.....	35.00	.....	.....	.....	.....	.....
1898	116.66	56.00	.....	.....	.....	172.66	.....	.....	.....	.....	.....
1899	120.00	.....	.....	34.60	.....	154.60	.....	.....	.....	.....	.....
1900	120.00	.....	.....	.....	.....	120.00	*8,782,500	.....	4	4	.....
1901	120.00	55.00	.....	30.62	.....	205.62	.....	.....	.....	.....	.....

*Run only twenty hours for testing.

VADNAIS LAKE STATION.

Year.	Salaries.	Fuel.	Machine Oil and Waste.	Repairs and Supplies.	Kerosene Oil	Total.	Water Pumped.		Fuel, Coal, Etc.	
							Annually.	Daily.	Annually.	Daily.
1891	$1,100.00	$1,081.68	$50.75	$197.12	$6.36	$2,435.91	207,750,000		246,800	
1892	1,020.00	1,905.25	73.71	102.19	25.90	3,127.05				
1893	600.00			21.35		621.35				
1894	912.50	1,508.99	21.06	216.75	20.60	2,679.90	337,160,000		624,387	
1895	848.33	1,105.00	47.50	31.58	11.64	2,044.05	237,043,000		550,000	
1896 (13 months)	1,147.48	1,618.77	44.22	38.76	32.52	2,881.75	938,611,850	2,364,262	612,614	
1897	754.00	479.83	6.59	46.92	9.81	1,297.15	290,299,356	795,341	195,950	
1898	1,006.00	1,040.49	65.82	73.81	18.55	2,213.67	924,765,600	4,509,561	589,300	
1899	896.00	776.43	12.18	142.13	16.31	1,843.05	555,596,800	4,982,464	337,050	2,963
1900	786.00	307.30	39.54	167.10	12.50	1,312.44	311,731,000	4,996,349	172,200	2,756
1901	818.00	625.73	38.30	21.04	17.16	1,520.23	493,940,400	5,100,470	263,300	2,780

WEST ST. PAUL STATION.

1893	$1,237.75	$589.63	$29.72	$23.50	$15.10	$1,895.70	10,015,722	27,440	209,043	571
1894	1,320.00	328.96	2.88	28.83	14.20	1,694.87	9,123,480	24,990	169,220	463
1895	1,320.00	299.50	5.27	26.47	9.08	1,660.32	10,520,640	28,848	174,600	479
1896 (13 months)	1,430.00	529.88	4.58	33.37	12.00	2,009.83	13,497,120	33,998	212,200	535
1897	1,320.00	361.22	5.36	42.86	11.60	1,741.04	16,018,200	43,886	229,800	629
1898	1,320.00	355.97	1.69	40.76	9.00	1,727.42	22,668,660	61,654	269,200	742
1899	1,340.00	448.57	13.44	151.43	12.00	1,965.44	18,803,280	51,515	248,216	680
1900	1,375.00	530.76	7.00	52.40	9.88	1,975.13	16,084,108	44,066	224,650	615
1901	1,380.00	561.36		79.90	19.88	2,041.14	17,682,660	48,445	240,800	659

CENTERVILLE STATION.

1897	$843.50	$1,764.85	$35.92	$2.58	$9.54	$2,656.39				
1898	902.00	12.00	38.58	16.18	9.41	978.17	595,535,200	14,029,638	160¼	4 cords
1899	1,085.75	385.75	71.79	60.12	18.64	1,622.05	1,920,398,000	14,846,597	474½	3½ cords
1900	1,015.50	1,161.95	41.11	97.48	17.64	2,333.68	1,037,764,000	14,659,841	242¾	3.29 cords
1901	1,002.50	1,129.05	26.30	47.76	19.48	2,225.09	1,462,345,200	15,142,410	328	3.4 cords

RESERVOIR.

Year.	Salaries.	Year.	Salaries.	Year.	Salaries.
1891	$405.00	1895	$405.00	1899	$480.00
1892	405.00	1896 (13 months)	430.00	1900	480.00
1893	405.00	1897	405.00	1901	480.00
1894	405.00	1898	465.00		

TABLE NO. 18.

COMPARATIVE STATEMENT OF HOSE VIOLATIONS FOR 1894-5-6-7-8-9-1900-1901.

Violations.	1894.			1895.			1896.			1897.			1898.			1899.			1900.			1901.		
	High.	Low.	Total.	High.	Low.	Total.	High.	Low.	Total.	High.	Low.	Total.	High.	Low.	Total.	High.	Low.	Total.	High.	Low.	Total.	High.	Low.	Total.
Hose, 1 violation	200	129	329	136	87	223	155	46	201	91	9	100	130	15	145	56	11	67	198	55	253	133	17	150
Hose, 2 violations	28	16	44	5	1	6	10	3	13	1	...	1	5	...	5	...	...	...	3	2	5	4	1	5
Hose, 3 violations	13	7	20	1	...	1	1	1	2	2	...	2	...	...	...	...	...	...	...	...	...	1	...	1
Hose, 4 violations	2	3	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hose, 5 violations	1	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hose, 7 violations	2	1	3	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...
Reel, 6 to 9 p. m., 1 violation	185	50	235	34	...	34	61	4	65	37	1	38	65	1	66	19	4	23	60	11	71	5	1	6
Reel, 6 to 9 p. m., 2 violations	22	14	36	6	...	6	1	...	1	2	...	2	1	...	1	...	...	...	2	...	2	...	...	...
Reel, 6 to 9 p. m., 3 violations	6	2	8	2	...	2	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Reel, 6 to 9 p. m., 4 violations	2	1	3	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Reel, 6 to 9 p. m., 7 violations	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hose, all day, 1 violation	162	34	196	1	...	1	40	3	43	26	9	35	68	...	68	51	8	59	36	7	43	25	7	32
Hose, all day, 2 violations	23	9	32	1	...	1	...	...	...	3	...	3	...	...	...	...	...	...	...	...	...	...	...	...
Hose, all day, 3 violations	2	4	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...
Hose, all day, 4 violations	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Totals	648	274	922	188	88	276	269	57	326	163	19	182	269	16	285	126	23	149	300	75	375	168	26	194

NUMBER OF PERMITS ISSUED ANNUALLY TO PLUMBERS SINCE 1884.

1884	718	1889	2,424	1894	1,065	1899	1,270
1885	1,454	1890	2,182	1895	1,770	1900	1,362
1886	1,497	1891	1,991	1896	1,173	1901	1,712
1887	1,610	1892	1,649	1897	1,060		
1888	1,707	1893	1,362	1898	1,104		

TABLE NO. 19.

STATEMENT SHOWING THE NUMBER MILES OF PIPE LAID ANNUALLY TO DATE, EXPENSE OF SAME, FRONTAGE TAX, ETC.

DATE.	MAINS LAID. Miles.	MAINS LAID. Feet.	Expenditure on Account of Laying Mains.	Construction Outside of City.	Annual Maintenance.	No. of Applications for Taps.	Annual Receipts from Consumers.	Increase.	Frontage Tax Receipts.	No. of Fire Hydrants in Use.	Frontage Tax Assessments.	Y'rs Frontage Tax has been Paid incl. '94.	Years more to Pay on Basis of 10 Years.
To Aug. 10, 1882	23	1,662	.....	.....	.....	2,007	.....	.....	.....	188	.....	.....	.....
From Aug. 10, 1882, to Dec. 1, 1882	....	3,793	a $12,300.44	$1,566.80	$1,674.58	118	.....	.....	.....	198	.....	.....	.....
From Dec. 1, 1882, to Dec. 1, 1883	4	4,807	61,003.97	100,021.19	6,854.30	301	.....	.....	.....	236	.....	11	.....
From Dec. 1, 1883, to Dec. 1, 1884	16	1,220	157,189.31	609,686.93	11,473.84	500	.....	.....	.....	315	$12,852.76	10	.....
From Dec. 1, 1884, to Dec. 1, 1885	23	2,583	207,586.90	40,148.36	b 19,275.58	1,009	.....	.....	$12,269.90	491	20,590.06	9	1
From Dec. 1, 1885, to Dec. 1, 1886	18	3,334	138,694.54	19,657.46	17,976.64	1,008	.....	.....	19,538.26	673	33,787.68	8	2
From Dec. 1, 1886, to Dec. 1, 1887	20	2,207	225,443.70	32,975.47	22,806.58	1,072	$106,635.23	$12,976.71	32,495.91	868	46,388.88	7	3
From Dec. 1, 1887, to Dec. 1, 1888	28	3,392	288,018.19	97,736.31	23,799.81	1,218	112,720.01	6,084.18	43,002.60	1,134	58,609.10	6	4
From Dec. 1, 1888, to Dec. 1, 1889	35	4,963	257,680.58	80,690.69	26,122.69	1,818	124,920.90	12,200.89	55,066.01	1,471	76,706.21	5	5
From Dec. 1, 1889, to Dec. 1, 1890	26	4,085	211,013.64	26,026.29	c 36,082.75	1,407	138,913.61	13,992.71	73,079.70	1,748	99,680.96	4	6
From Dec. 1, 1890, to Dec. 1, 1891	5	3,696	46,029.69	38,937.07	38,473.82	1,075	159,561.29	20,648.48	88,987.80	1,813	117,947.95	3	7
From Dec. 1, 1891, to Dec. 1, 1892	14	928	e 118,343.20	41,327.25	35,349.12	881	171,164.69	11,603.40	112,082.57	1,968	123,886.45	2	8
From Dec. 1, 1892, to Dec. 1, 1893	8	1,946	63,325.15	4,590.46	36,404.84	625	177,595.21	6,430.62	107,899.11	2,067	135,336.46	1	9
From Dec. 1, 1893, to Dec. 1, 1894	6	646	42,287.17	6,198.62	d 39,139.72	502	178,967.32	1,372.11	112,115.05	2,131	143,001.73	.....	10
From Dec. 1, 1894, to Dec. 1, 1895	8	13	f 81,360.58	24,624.65	39,006.14	701	179,246.52	279.20	147,171.40	2,200	125,374.26	.....	.....
From Dec. 1, 1895, to Dec. 31, 1896	3	3,185	h 64,925.03	116,564.23	g 41,800.24	540	g 190,714.78	g 11,468.26	123,172 48	2,232	114,925.17	.....	.....
From Dec. 31, 1896, to Dec. 31, 1897	2	490	23,305.72	27,885.79	37,105.41	430	170,796.35	i 19,918.43	106,448.35	2,249	104,052.58	.....	.....
From Dec. 31, 1897, to Dec. 31, 1898	2	3,010	19,128.60	54,396.92	38,124.41	530	167,154.27	i 3,642.08	103,927.35	2,268	93,075.68	.....	.....
From Dec. 31, 1898, to Dec. 31, 1899	2	4,186	23,831.66	20,338.82	42,922.82	666	167,343.23	188.96	102,548.02	2,294	75,882.60	.....	.....
From Dec. 31, 1899, to Dec. 31, 1900	3	4,356	38,888 48	16,693.20	43,507.50	685	180,810.19	13,466.96	78,261.81	2,321	56,882.83	.....	.....
From Dec. 31, 1900, to Dec. 31, 1901	3	3,607	34,087.38	13,057.88	47,517.38	820	186,983.30	6,173.11	57,174.72	2,346	40,582.23	.....	.....
Total	260	89	.....	.....	.....	.....	.....	.....	$1,385,301.04	.....	.....	.....	.....
Less relaid and abandoned	8	2,040	.....	.....	.....	.....	.....	.....	3,279.98	.....	.....	.....	.....
Net amount mains	251	3,329	.....	.....	.....	.....	.....	.....	$1,382,021.06	.....	.....	.....	.....

a This includes relaying 16-inch pipe on Lafayette avenue near Trout Brook, of regrading street, at an expense of $4,677.97.
b Pumping station established for high service in fall of 1884.
c Pumping station established for well plant at Vadnais lake, also Rice lakes.
d Pumping station established for high service in West St. Paul in fall of 1892.
e This includes laying the 20-inch force main to reservoir.
f This includes laying 9,234 feet of 30-inch supply main on Dale street from reservoir to Dale and Front, at an expense of $88,365.78.
g This is for a period of 13 months.
h This includes laying 7,680 feet of 36-inch cast iron force main from McCarron lake pumping station to high service reservoir, at an expense of $49,347.64.
i Decrease.

TABLE NO. 20

STATEMENT SHOWING NUMBER OF METERS, CONSUMPTION OF TER, AMOUNTS RECEIVED FOR WATER AND METER RENTS, AVERAGE RATE PER MONTH.

Month.	Number of Meters.	Consumption. Cubic Feet.	Amounts Received for Water.	Amounts Received for Meter Rent.	Average Rate
1896.					
January	1,155	5,970,603	$4,824.93	$234.00	
February	1,164	6,238,792	5,022.64	235.60	
March	1,224	6,187,889	5,000.19	245.42	
April	1,241	6,453,270	5,212.08	249.48	
May	1,285	6,274,503	5,164.62	255.48	
June	1,309	6,809,003	5,587.64	258.61	
July	1,378	6,523,906	5,387.94	274.81	
August	1,415	6,801,623	5,596.42	274.80	
September	1,489	7,892,005	6,305.34	289.77	
October	1,515	6,518,949	5,324.12	292.80	
November	1,526	6,541,652	5,309.11	290.25	
December	1,546	5,935,142	4,886.44	291.05	
Totals		78,147,427	$63,621.47	$3,192.07	
1897.					
January	1,594	6,249,691	$5,103.00	$299.19	
February	1,601	5,836,416	4,821.99	298.73	
March	1,719	6,123,406	5,011.21	315.12	
April	1,758	6,095,240	5,072.35	322.14	
May	1,821	5,947,842	4,274.06	332.49	
June	1,867	6,298,849	4,464.09	339.41	
July	2,000	6,320,138	4,569.55	360.46	
August	2,059	6,671,269	4,738.88	366.37	
September	2,183	6,616,801	4,840.61	389.06	
October	2,262	6,542,878	4,764.48	399.73	
November	2,286	6,394,309	4,62[illegible].55	399.97	
December	2,298	6,295,372	4,574.95	402.38	
Totals		75,392,211	$56,855.72	$4,225.05	
1898.					
January	2,380	6,182,474	$4,507.74	$410.23	
February	2,389	6,152,653	4,502.29	412.87	
March	2,568	6,583,278	4,769.19	442.77	
April	2,619	6,313,093	4,721.24	451.35	
May	2,672	6,893,109	5,040.66	462.86	
June	2,756	7,404,121	5,391.83	475.33	
July	2,898	7,320,745	5,500.73	495.65	
August	2,998	7,895,577	5,793.18	507.11	
September	3,186	8,365,497	6,171.40	538.33	
October	3,326	7,610,828	5,591.12	562.18	
November	3,346	7,664,539	5,545.89	563.80	
December	3,355	7,546,785	5,472.34	563.94	
Totals		85,932,699	$63,007.61	$5,886.42	
1899.					
January	3,414	7,442,389	$5,476.60	$570.10	
February	3,419	7,306,418	5,456.61	571.34	
March	3,476	7,962,725	5,863.22	575.23	
April	3,543	7,500,780	5,613.55	585.34	
May	3,590	7,751,683	5,805.65	598.92	
June	3,619	7,683,319	5,727.94	603.29	
July	3,685	8,336,793	6,291.41	616.39	
August	3,745	8,423,218	6,472.18	623.32	
September	3,894	8,126,342	6,112.72	646.79	
October	4,020	7,680,360	5,815.85	666.65	
November	4,043	8,337,560	6,100.93	672.33	
December	4,063	7,702,400	5,780.30	672.07	
Totals		94,253,987	$70,516.96	$7,401.77	

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TABLE NO. 20.—Continued.

MONTH.	Number of Meters.	Consumption. Cubic Feet.	Amounts Received for Water.	Amounts Received for Meter Rent.	Average Rate per 100 Cubic Feet.
1900.					
January	4,151	7,574,302	$5,767.33	$683.05	.0761
February	4,174	7,376,481	5,638.34	685.61	.0763
March	4,286	7,741,929	5,916.61	699.99	.0765
April	4,314	8,509,183	6,331.56	713.37	.0745
May	4,366	8,776,266	6,779.70	720.92	.0772
June	4,423	10,129,914	7,829.88	729.32	.0772
July	4,521	9,297,573	7,121.37	745.60	.0765
August	4,559	9,988,059	7,562.38	754.22	.0757
September	4,655	8,442,816	6,600.74	770.29	.0782
October	4,770	8,531,383	6,516.80	787.93	.0763
November	4,789	8,349,575	6,339.47	788.73	.0759
December	4,812	7,932,886	6,107.93	789.49	.0769
Totals		102,650,367	$78,512.11	$8,868.52	.0765
1901.					
January	4,859	8,820,387	$6,623.91	$795.56	.0751
February	4,877	7,988,407	6,101.51	796.22	.0763
March	4,965	8,062,137	6,209.85	810.40	.0770
April	5,011	8,199,123	6,336.16	820.83	.0772
May	5,053	8,636,644	6,773.11	829.76	.0784
June	5,104	9,651,531	7,384.43	836.42	.0765
July	5,209	10,713,805	8,192.86	852.00	.0764
August	5,251	11,066,457	8,547.48	858.58	.0772
September	5,402	9,899,034	7,557.38	884.12	.0763
October	5,527	9,156,338	7,046.44	900.98	.0770
November	5,550	9,142,287	7,005.79	905.01	.0766
December	5,593	10,587,881	7,745.93	910.18	.0732
Totals		111,924,031	$85,524.85	$10,200.06	.0764

LIST OF VOUCHERS.

JANUARY, 1901.

No. of Voucher.	Name.	Claim.	Amount.
11652	Otto Bremer, city treasurer,	Pay roll for December	$4,180.45
11653	Otto Bremer, city treasurer	Interest due Jan. 1, 1901	5,625.00
11654	Pittsburg Meter Co	Estimate No. 9, meters	784.00
11655	Otto Bremer, city treasurer	Interest due Feb. 1, 1901	3,700.00
11656	F. L. Gregory	Estimate No. 6, fuel	883.03
11657	George Regelsberger	Plumbing at office	11.55
11658	South Park Foundry & Machine Co	Repacking hydrant valves	29.40
11659	Griggs Bros	Corn and oats	40.72
11660	Pioneer Press Co	Printing specifications	27.50
11661	St. Paul Sash, Door & Lumber Co	Hydrant drip boxes	7.00
11662	J. G. Duggan	Blacksmithing	9.50
11663	Pioneer Press Co	Advertising	6.15
11664	Gribben Lumber Co	Lumber	27.29
11665	Brown, Treacy & Co	Stationery	8.25
11666	H. C. Boyeson	Stationery	13.44
11667	McGill-Warner Co	Advertising	11.00
11668	H. E. Wedelstaedt & Co	Stationery	2.40
11669	N. W. Stamp Works	Stamps (rubber)	.50
11670	Curtis Printing Co	Job printing	.75
11671	Wm. Kennedy Printing Co	Job printing	2.00
11672	St. Paul Hardware Co	Hardware	1.35
11673	Adam Decker & Co	Strap hinges	.60
11674	Mitsch Wagon & Carriage Co	Wheelbarrows and buckets to order	23.40
11675	P. N. Lindquist	Horseshoeing	13.50
11676	Foley Bros. & Kelly Merc. Co	Candles and matches	11.10
11677	Estate of James Gilfillan	Rent of storage lot	25.00
11678	Tierney & Co	Hay and bran	17.35
11679	Cornplanter Oil Co	Estimate No. 10, oils	35.24
11680	D. L. Bell	Louisville cement	6.60
11681	Crane & Ordway Co	Pipe fittings	1.67
11682	T. L. Blood & Co	Paint	2.00
11683	Farwell, Ozmun, Kirk & Co	Wire	2.52
11684	Robinson & Cary Co	Rope and oil	4.71
11685	Western Supply Co	Pipe and pipe fittings	9.16
11686	Chris Johnson	Estimate No. 3, pipe laying	85.70
11687	Patrick Doherty	Estimate No. 9, pipe laying	70.89
11688	Patrick Doherty	Extra labor	5.75
11689	James Middleton	Erroneous frontage tax	7.00
11690	John Caulfield	Cash advanced as per enclosed receipts	75.96
			$15,774.43

LIST OF VOUCHERS—*Continued.*

FEBRUARY, 1901.

No. of Voucher.	Name.	Claim.	Amount.
11691	Otto Bremer, city treasurer	Pay roll for January	$4,079.41
11692	Otto Bremer, city treasurer	Interest due March 1, 1901	6,750.00
11693	Joseph F. Lamotte	Estimate No. 1, cord wood and piles	202.84
11694	Thomson Meter Co	Meters and repairs	63.65
11695	George Regelsberger	Repairing radiator valves	1.65
11696	Joseph N. Forcier	Board and stabling, foreman	4.05
11697	Herman Paar	1 Kerm lamp burner	1.75
11698	The Globe Co	Advertising	1.00
11699	Pioneer Press Co	Advertising	30.75
11700	Wm. Kennedy Printing Co	Job printing	20.85
11701	J. G. Duggan	Blacksmithing	13.15
11702	Augusta Weide	Erroneous frontage tax	8.50
11703	J. A. Gordy & Co	Lumber and labor on same	50.73
11704	Ryan Drug Co	Miscellaneous supplies	16.09
11705	Mahle Wagon Co	Blacksmithing	2.52
11706	Western Supply Co	Pipe fittings	2.08
11707	Northwestern Stamp Works	Lead seals	1.25
11708	P. J. Maybell Stationery Co	Stationery	6.52
11709	Foley Bros. & Kelly Merc. Co	Matches, candles and soap	16.90
11710	Robinson & Cary Co	Blasting tools	10.08
11711	Farwell, Ozmun, Kirk & Co	Tools, etc	7.70
11712	American Electric Co	Office wire	.90
11713	Crane & Ordway Co	Valves	3.09
11714	St. Paul Daily News	Advertising	1.80
11715	Wyckoff, Seamans & Benedict	Letter books	4.00
11716	McGill-Warner Co	Job printing	4.75
11717	Andrew Schoch Grocery Co	Pail Klearsall soap	2.00
11718	Henry E. Wedelstaedt & Co	Stationery	2.07
11719	Chas. Friend & Son	Stable supplies	1.00
11720	Volkszeitung Printing Co	Advertising	1.00
11721	Prendergast Bros	Sheet zinc	.60
11722	Adam Decker & Co	Nails, etc	7.75
11723	P. N. Lindquist	Horseshoeing	18.00
11724	Frank L. Gregory	Estimate No. 7, fuel	93.55
11725	Cornplanter Oil Co	Estimate No. 11, oil and gasoline	19.76
11726	M. J. O'Neill	Gas mantles and chimneys	6.10
11727	D. L. Bell	Cement	10.80
11728	Perkins Mfg. Co	200 wire springs	12.00
11729	Dispatch Printing Co	Advertising	1.20
11730	Arnold Uhler	Sharpening tools	3.98
11731	St. Paul Rubber Co	Packing	4.69
11732	Brown, Treacy & Co	Stationery	43.01
11733	Estate of James Gilfillan	Rent of storage lot	25.00
11734	John Caulfield	Bills paid per receipts attached	90.18
			$11,648.70

LIST OF VOUCHERS—*Continued.*

MARCH, 1901.

No. of Voucher.	Name.	Claim.	Amount.
11735	Otto Bremer, city treasurer	Pay roll for February	$4,391.99
11736	Joseph F. Lamotte	Estimate No. 2, cutting wood	501.60
11737	Chris. Johnson	Estimate No. 2 and final, pipe laying	17.01
11738	Patrick Doherty	Estimate No. 10, pipe laying	166.83
11739	J. G. Duggan	Sharpening tools	6.00
11740	Wm. Kennedy Printing Co	Job printing	50.04
11741	St. Paul Foundry Co	Repairs, 4 million pumps	59.45
11742	Scribner & Libby Co	Repairs pumps	39.16
11743	McGill-Warner Co	Job printing	11.50
11744	Griggs Bros	Oats	51.43
11745	George Regelsberger	Case toilet paper	7.75
11746	N. W. Stamp Works	Repairing machine	1.50
11747	Pioneer Press Co	Blank books and job printing	48.20
11748	Frank Kohout	Window glass broken on Michigan street	3.65
11749	Great Northern Ry. Co	Repairs over Rice street main	4.69
11750	Otto Bremer, city treasurer	Interest due April 1, 1901	24,950.00
11751	Frank L. Gregory	Estimate No. 8, fuel	815.92
11752	The Western Supply Co	Cotton waste, etc	13.47
11753	Robinson & Cary Co	Powder, fuse, etc	59.60
11754	Foley Bros. & Kelly Merc. Co	Candles and matches	25.34
11755	Crane & Ordway Co	Pipe fittings	6.68
11756	Farwell, Ozmun, Kirk & Co	Mops, pumping station	.40
11757	H. P. Rugg & Co	Packing and nipples	3.76
11758	Ramaley Publishing Co	Job printing	1.70
11759	Wyckoff, Seamans & Benedict	Tabulator for typewriter	18.00
11760	Brown, Treacy & Co	Stationery	12.49
11761	Adam Decker & Co	Nails and tools	.50
11762	R. J. Maybell Sta. Co	Stationery	21.49
11763	H. C. Harmon	Lumber	4.00
11764	N. W. Telephone Exchange Co	Repairing private line	3.50
11765	Union Brass & Metal Mfg. Co	Repairs, 4 million pumps	1.50
11766	Arnold Uhler	Sharpening tools	12.65
11767	Weston Electrical Instrument Co	Volt. Port. meter for testing	76.25
11768	Estate of James Gilfillan	Rent of storage lot	25.00
11769	Wm. Kennedy Printing Co	Job printing	3.25
11770	Chas. Friend & Son	Harness fittings	.90
11771	P. N. Lindquist	Horseshoeing	8.50
11772	P. Roby & Co	Keys	.50
11773	Joseph A. Rogers	Insurance on wood	12.00
11774	Cornplanter Oil Co	Estimate No. 12, oils	30.91
11775	Schroeder & Dickinson	Recaning 2 stools	1.30
11776	H. Mueller Mfg. Co	Tapping machines	139.50
11777	St. Paul Globe	Advertising	20.21
11778	Carl Neumann	Meals for country trip	25.95
11779	John Caulfield	Bills paid per receipts attached	94.21
11780	The Western Supply Co	Estimate No. 1 and final, lead pipe	2,497.46
11781	Raymond Lead Co	Pig tin	158.12
11782	Gribben Lumber Co	Lumber	22.13
11783	H. C. Sinks	Disinfecting office and shop	15.00
11784	Pittsburgh Meter Co	Estimate No. 10 and final, meters	840.60
11785	St. Paul Daily News	Advertising	2.70
11786	Pioneer Press Co	Job printing	52.50
			$35,338.79

LIST OF VOUCHERS—*Continued.*

APRIL, 1901.

No. of Voucher.	Name.	Claim.	Amount.
11787	Otto Bremer, city treasurer	Pay roll for March, 1901	$4,413.24
11788	Patrick Doherty	Estimate No. 11, pipe laying, 1900	150.31
11789	John F. Hall	Wood for Baldwin Lake station.	55.00
11790	George Regelsberger	Plumbing work	3.30
11791	Griggs Bros	Bran	1.37
11792	St. Paul Electric Co	Electric fixtures	1.87
11793	J. G. Duggan	Blacksmithing and repairs	24.06
11794	Otto Bremer, city treasurer	Interest due, May 1, 1901	8,750.00
11795	Estate of James Gilfillan	Rent of storage lot	25.00
11796	Northwestern Telephone Exchange Co	Repairs to private line	3.50
11797	Union Brass & Metal Mfg. Co	Repair street sprinkling hydrants	6.10
11798	H. A. Muckle Mfg. Co	Repainting and repairing buggy.	38.00
11799	P. N. Lindquist	Horseshoeing	8.50
11800	Scribner-Libby Co	Making stuffing boxes	7.50
11801	Joseph N. Forcier	Board of foreman	9.00
11802	The Engineering Record	One year's subscription	5.00
11803	South Park Foundry & Machine Co	Estimate No. 1, special castings	18.09
11804	Mitsch Wagon & Carriage Co	New spring truck	85.00
11805	Adam Decker & Co	Tools	4.40
11806	H. Mueller Mfg. Co	Brass Goods	77.54
11807	Chas. Friend & Son	Harness fittings	6.60
11808	Wm. Kennedy Printing Co	Job printing	4.00
11809	Arnold Uhler	Sharpening tools	3.59
11810	N. W. Stamp Works	Meter seals, etc	2.00
11811	Pittsburgh Meter Co	Meter fittings	7.80
11812	F. L. Gregory	Estimate No. 1, fuel	21.50
11813	Cornplanter Oil Co	Estimate No. 13, oils	1.35
11814	Pioneer Press Co	Printing annual report	326.25
11815	Pioneer Press Co	Job printing	34.00
11816	Brown, Treacy & Co	Stationery	16.03
11817	Crane & Ordway Co	Hose, pipe, fittings, etc	11.49
11818	Boeringer & Son	Metallic tape	1.35
11819	Robinson & Cary Co	Tools	22.29
11820	T. L. Blood & Co	Oil and paint	1.40
11821	Foley Bros. & Kelly Merc. Co	Candles, tea lead	13.70
11822	R. J. Maybell Stationery Co	Stationery	3.44
11823	St. Paul Rubber Co	Packing cut to order	1.97
11824	Ramaley Publishing Co	Printing envelopes	.60
11825	Wyckoff, Seamans & Benedict	Stationery	5.30
11826	McGill-Warner Co	Job printing	5.50
11827	Die Volkszeitung Printing & Publishing Co	Advertising	1.80
11828	Dispatch Printing	Advertising	3.60
11829	St. Paul Globe	Advertising	3.50
11830	Joseph Lamotte	Estimate No. 3 and final, cutting wood	443.41
11831	John Caulfield	Bills paid per receipts attached.	119.64
11832	Pittsburgh Meter Co	Estimate No. 1, meters	647.00
			$15,395.89

MAY, 1901.

11833	Otto Bremer, city treasurer	Pay roll for April, 1901	$4,996.53
11834	Otto Bremer, city treasurer	Interest due June 1, 1901	7,000.00
11835	George Regelsberger	Plumbing at McCarron Lake Station	80.00
11836	St. Paul Hardware Co	Tools	2.80
11837	Wm. Kennedy Printing Co	Job printing	3.20
11838	Mannheimer Bros	Sash curtains	1.25

LIST OF VOUCHERS—*Continued.*

JULY, 1901.

No of Voucher.	Name.	Claim.	Amount.
11962	Otto Bremer, city treasurer	Pay roll for June, 1901	$6,337.28
11963	Otto Bremer, city treasurer	For sinking fund	25,000.00
11964	Otto Bremer, city treasurer	Interest due August 1, 1901	3,700.00
11965	Ramaley Publishing Co	Printing postal cards	1.20
11966	Scribner-Libby Co	Repairs W. S. pumping station	22.00
11967	Chas. Quinn	Horseshoeing	2.00
11968	Fred Stanley	Re-shingling West Side station	30.45
11969	J. G. Duggan	Blacksmithing	10.50
11970	John Caulfield	Bills paid per receipts attached	145.47
11971	R. D. Wood & Co	Estimate No. 1, valves	442.85
11972	N. W. Stamp Works	Repairing stamps, etc	2.00
11973	St. Paul Machine Works	Repairing lawn mower, etc	2.00
11974	N. W. Copper & Brass Works	Brass rod	1.50
11975	Diebold Safe & Lock Co	Repairing book case roller	1.00
11976	John Griffin	Painting smoke stacks	50.00
11977	Robinson & Cary Co	Powder, fuse and tools	131.80
11978	The Western Supply Co	Pipe and pipe fittings	61.50
11979	T. L. Blood & Co	Paint	.95
11980	R. J. Maybell Stationery Co	Stationery	3.02
11981	McGill-Warner Co	Index for frontage tax	1.25
11982	Brown, Treacy & Co	Stationery	8.94
11983	Wyckoff, Seamans & Benedict	Stationery	1.60
11984	Pioneer Press Co	Meter consumers record (C)	20.00
11985	The Globe Co	Advertising	1.00
11986	D. L. Bell	Cement	4.80
11987	J. C. Horrigan	Livery team	8.00
11988	Foley Bros. & Kelly Merc. Co	Meters	6.30
11989	Nimis & Nimis	Keys	.50
11990	Ryan Drug Co	Supplies	5.77
11991	F. W. Luley & Son	Tallow	.40
11992	Wm. Haas & Co	Photos of Electrolysis	19.80
11993	St. Paul Electric Co	Electric lamp cord	25.97
11994	Jas. C. Clark for W. F. Pieper	Overcharge on temporary main	19.50
11995	P. N. Lindquist & Co	Horseshoeing	5.50
11996	Estate of James Gilfillan	Rent of storage lot	25.00
11997	F. Koller	Overcharge on connection	8.00
11998	Farwell, Ozmun, Kirk & Co	Tools	2.86
11999	R. White	Veterinary services	2.00
12000	H. P. Rugg & Co	Pipe fittings	.38
12001	F. L. Gregory	Estimate No. 13, fuel	7.00
12002	Union Water Meter Co	Meters	90.00
12003	Cornplanter Oil Co	Oil and gasoline	23.30
12004	South Park Foundry & Machine Co	Estimate No. 3, special castings	108.04
12005	The Crane & Ordway Co	Estimate No. 2, brass goods	206.22
12006	Crane & Ordway Co	Valves	5.17
12007	A. J. Stobbart	Expenses to Anoka	4.80
12008	Chas. Friend & Son	Harness fittings	2.00
12009	Leon St. Marie	Board of Chas. Erickson	1.85
12010	Joseph N. Forcier	Meals and stabling	.75
12011	Louis Reinhardt	Refunded frontage tax	4.00
12012	A. Wellman	Refunded frontage tax	5.00
12013	Anna Zimmermann	Refunded frontage tax	4.00
12014	Crane & Ordway Co	Meter fittings	2.50
12015	Arnold Uhler	Sharpening tools	25.38
12016	R. W. Hunt & Co	Inspecting pipe	54.49
12017	Pittsburg Meter Co	Estimate No. 3, meters	667.70
12018	N. W. Shot & Lead Works	Lead pipe	59.68
12019	Otto Bremer, city treasurer	Street sprinkling	5.76
			$37,390.73

LIST OF VOUCHERS—*Continued.*

JUNE, 1901.

No. of Voucher.	Name.	Claim.	Amonnt.
11901	Otto Bremer, city treasurer	Pay roll for May, 1901	$5,881.48
11902	Otto Bremer, city treasurer	Interest on bonds due July 2	5,625.00
11903	Patrick Doherty	Estimate No. 13 and final, pipe laying 1900	138.74
11904	Western Supply Co	Estimate No. 1 and final, pig lead	764.50
11905	South Park Foundry & Machine Co	Valve, brass bolts, etc	42.00
11906	John Fitzgerald, supt. workhouse	Brooms for cleaning conduit, etc	8.20
11907	Perkins Mfg. Co	Brass springs, etc	2.00
11908	Pioneer Press Co	Blank books and printing	15.75
11909	Dwight M. Baldwin	Oats	46.09
11910	H. G. Perske, register of deeds	Recording deeds and plats	6.00
11911	Frank Kahout	Damages making connections	10.49
11912	Adam Decker & Co	Hardware	14.70
11913	Edward Ayd	Overcharge on connection	39.08
11914	J. G. Duggan	Blacksmithing	10.85
11915	St. Paul Dispatch	Advertising	.90
11916	Pioneer Press Co	Job printing and advertising	8.40
11917	Wm. Kennedy Printing Co	Job printing	2.00
11918	Brown, Treacy & Sperry Co	Stationery	22.19
11919	Ramaley Publishing Co	Job printing	.50
11920	Wyckoff, Seamans & Benedict	Repairs typewriter	.50
11921	Henry E. Wedelstaedt & Co	Stationery	7.00
11922	McGill-Warner Co	Job printing	2.80
11923	R. J. Maybell Stationery Co	Stationery	11.13
11924	Daily News Publishing Co	Advertising	.90
11925	Volkszeitung Printing & Pub. Co.	Advertising	.60
11926	N. W. Stamp Works	Plated badge	.60
11927	St. Paul Fire & Marine Insurance Co	Insurance on dwelling at reservoir	14.40
11928	Chas. Friend & Son	Repairs	.60
11929	Henry Kremer	Horse clipping	2.00
11930	Adam Decker & Co	Hardware	16.70
11931	Estate of Jas. Gilfillan	Rent of storage lot	25.00
11932	Jos. F. Paislee	Horseshoeing	2.00
11933	D. L. Bell	Cement	4.00
11934	P. N. Lindquist	Horseshoeing	5.50
11935	Martin Feist	Lunch for men cleaning conduit	4.00
11936	Scribner-Libby Co	Roofing office building	70.00
11937	St. Paul Rubber Co	Hip rubber boots	3.85
11938	Mitsch Wagon & Carriage Co	Repairing buggy	9.75
11939	Morehead & Horrigan	Livery	11.00
11940	Foley Bros. & Kelly Co	Matches and candles	6.30
11941	Nimis & Nimis	Repairing blasting machine	3.00
11942	Ryan Drug Co	Supplies	12.52
11943	Gribben Lumber Co	Lumber	24.00
11944	R. White	Veterinary services	3.00
11945	H. P. Rugg & Co	Pipe fittings	.40
11946	Robinson & Cary Co	Pump valves, fuse, etc	21.36
11947	The Western Supply Co	Pipe and pipe fittings	75.60
11948	Crane & Ordway Co	Pipe fittings	20.98
11949	Farwell, Ozmun, Kirk & Co	Lawn mower, water coolers, etc.	8.88
11950	Arnold Uhler	Sharpening tools	17.68
11951	Cornplanter Oil Co	Estimate No. 15, gasoline	1.50
11952	J. H. Bohrer Sanitation Co	Cleaning vault 409 Fairview ave.	6.90
11953	F. L. Gregory	Estimate No. 12, fuel	716.81
11954	Otto Bremer, city treasurer	Street sprinkling	4.67
11955	P. R. L. Hardenbergh & Co	Leather for washers	5.36
11956	Union Brass & Metal Mfg. Co	Top nuts for valves	4.00
11957	National Meter Co	Register for Crown Piston meter	7.75
11958	John Caulfield	Cash advanced as per vouchers attached	112.11
11959	C. Collins	Blacksmithing	3.40
11960	H. A. Muckle Mfg. Co	Repainting buggy	15.00
11961	Hersey Mfg. Co	Meter fittings	18.16
			$13,920.58

LIST OF VOUCHERS—AUGUST, 1901—*Continued.*

No. of Voucher.	Name.	Claim.	Amount.
12081	U. S. Cast Iron Pipe & Foundry Co	Estimate No. 1, cast iron pipe..	6,270.05
12082	Western Supply Co	Galv. iron pipe and waste	75.83
12083	Chas. E. Green	Abstracts right of way	4.50
12084	Thos. Walazek	Erroneous frontage tax	4.00
12085	N. W. Telephone Exchange Co..	Repairing telephone line	3.05
12086	Crane & Ordway Co	Estimate No. 3, brass goods....	24.12
12087	Jas. Shiely	Estimate No. 11, drayage	116.50
12088	Union Water Meter Co	Meters	180.00
12089	John Caulfield	Cash advanced as per vouchers..	103.08
12090	South Park Foundry & Machine Co	Estimate No. 1, fire hydrants ..	322.50
12091	R. W. Hunt & Co	Inspecting pipe	77.02
			$39,067.07

SEPTEMBER, 1901.

12092	Otto Bremer, city treasurer	Pay roll for August, 1901	$8,417.21
12093	Otto Bremer, city treasurer	Interest due Oct. 1, 1901	24,950.00
12094	National Meter Co	Meter fittings	27.80
12095	Gribben Lumber Co	Lumber	63.08
12096	N. W. Shot and Lead Co	Lead pipe	225.31
12097	Diebold Safe & Lock Co	2 office keys	.50
12098	Michigan Brass & Iron Works...	Automatic drip valves	126.00
12099	N. W. Stamp Works	Dating stamp, etc	2.65
12100	Wm. Kennedy Printing Co	Job printing, 2 M Form 2	4.00
12101	Great Northern Ry. Co	Labor protecting tracks Snelling avenue	35.46
12102	South Park Foundry & Machine Co	Estimate No. 5, special castings.	56.40
12103	F. L. Gregory	Estimate No. 16, coal	516.77
12104	U. S. Cast Iron Pipe & Foundry Co	Estimate No. 2, pipe	1,248.03
12105	Wm. Haas & Co	Developing plates	3.60
12106	Pioneer Press Co	Job printing	100.00
12107	Charlie Quinn	Horseshoeing	2.00
12108	W. H. Bregger	Cleaning chimneys	3.00
12109	J. G. Duggan	Sharpening tools	14.35
12110	Wm. F. Porten	Estimate No. 1, engine house, Vadnais	2,596.75
12111	Robinson & Cary Co	Pig tin, fuse and packing	115.60
12112	Western Supply Co	Pipe, pipe fittings and waste....	57.86
12113	Crane & Ordway Co	Pipe fittings, etc	120.12
12114	Mitsch Wagon & Carriage Co....	Pair shafts for wagon	5.00
12115	Brown, Treacy & Sperry Co.....	Stationery	14.34
12116	Wyckoff, Seamans & Benedict...	Stationery	1.85
12117	R. J. Maybell Stationery Co.....	Stationery	1.40
12118	Ramaley Publishing Co	Job printing	2.30
12119	The Globe Co	Advertising	17.82
12120	Farwell, Ozmun, Kirk & Co.....	Spade	.83
12121	John C. Horrigan	Livery	11.00
12122	City Carriage Works	Repairing carriage	6.50
12123	Fred Schroeder	Livery	12.00
12124	Ryan Drug Co	Supplies	.91
12125	Foley Bros. & Kelly Co	Salt and candles	7.30
12126	Nicols, Dean & Gregg	Iron	5.49
12127	H. P. Rugg & Co	Pipe fittings	1.38
12128	Western Electric Co	Repair telephones, private office line	.55
12129	Joseph N. Forcier	Hardware	3.45

LIST OF VOUCHERS—SEPTEMBER, 1901—*Continued.*

No. of Voucher.	Name.	Claim.	Amount.
12130	Joseph F. Lamotte	Hauling oil and waste	1.25
12131	Joseph Garceau	Blacksmithing	.50
12132	Perkins Mfg Co	Wire cone springs	4.00
12133	St. Paul Hardware Co	Window cleaner	.35
12134	Union Brass & Metal Mfg. Co.	Top nuts on valves	4.80
12135	Franklin Machine Works	Thread cutting	1.00
12136	Estate of James Gilfillan	Rent of storage lot	25.00
12137	Diebold Safe & Lock Co	One doz. of brackets for comp. files	3.60
12138	D. H. Ball	Sharpening tools	.45
12139	D. L. Bell	Portland cement	10.40
12140	P. N. Lindquist	Horseshoeing	6.00
12141	Adam Decker & Co	Wire nails	40.73
12142	Gribben Lumber Co	Lumber	48.00
12143	Cornplanter Oil Co	Estimate No. 8, oils	17.42
12144	Jas. Shiely	Estimate No. 2, drayage	23.54
12145	St. Paul Rubber Co	Men's hip rubbers	36.63
12146	Pioneer Press Co	Repairing ledgers	28.00
12147	Ogden, Merrill & Greer	Lantern fixtures	1.26
12148	F. W. Luley & Son	Rendered tallow	2.00
12149	Richard Moffatt	Sharpening tools	3.55
12150	John Caulfield	Cash advanced as per receipts attached	121.04
12151	N. W. Shot & Lead Works	Coil lead pipe	11.08
12152	Pittsburg Meter Co	Estimate No. 5, meters	662.25
12153	Arthur J. Stobbart	Expenses to Anoka	2.75
12154	John Caulfield	W. D. from O. Dupre, 2.55 acres in N. W. of S. E. ¼ Sec. 10, T. 31, R. 22	62.50
			$39,896.71

OCTOBER, 1901.

12155	Otto Bremer, city treasurer	Interest due Nov. 1 & 2, 1901	$8,750.00
12156	C. H. Neuman and Chris. Schade	Overcharge on connection	4.00
12157	Arnold Uhler	Sharpening tools, etc	5.71
12158	Fred Stanley	Carpenter work	22.86
12159	H. M. Smyth Printing Co	Maps	75.00
12160	Gribben Lumber Co	Lumber	24.00
12161	South Park Foundry & Machine Co	Cast iron chimney top	22.00
12162	St. Paul Gas Light Co	Electric fans	5.10
12163	Chas. Quinn	Horseshoeing	2.00
12164	N. W. Stamp Works	Lead seals	1.25
12165	U. S. Cast Iron Pipe & Foundry Co	Estimate No. 3, cast iron pipe	2,657.18
12166	Crane & Ordway Co	Estimated No. 1 and final, lead pipe	2,103.99
12167	Crane & Ordway Co	Estimate No. 4, brass goods	40.20
12168	Bingham & Taylor	Estimate No. 2, valves and service boxes	626.84
12169	Pittsburg Meter Co	Estimate No. 6, meters	647.04
12170	South Park Foundry & Machine Co	Estimate No. 2, special castings	157.88
12171	Frank L. Gregory	Estimate No. 17, fuel	277.08
12172	Albert Rehbine	Hauling oil, etc	2.75
12173	Wm. Kennedy Printing Co	Job printing	50.04
12174	Estate of James Gilfillan	Rent of storage lot	25.00
12175	J. G. Duggan	Blacksmithing	12.20
12176	Pioneer Press Co	Blank books	23.25
12177	Watson & Howard	Insurance on dwelling, Vadnais	4.80

LIST OF VOUCHERS—OCTOBER, 1901—*Continued.*

No. of Voucher.	Name.	Claim.	Amount.
12178	W. S. Reed and John Voerge	Refund on street service	5.85
12179	South Park Foundry & Machine Co	Estimate No. 2, fire hydrants	129.00
12180	Otto Bremer, city treasurer	Pay roll for September, 1901	6,859.67
12181	Wm. Porten	Estimate No. 2, pumping station, Vadnais	1,700.00
12182	St. Paul Foundry Co	Catch basin cover, Vadnais	3.50
12183	D. L. Bell	Cement	26.60
12184	Dispatch Printing Co	Advertising	.90
12185	Pioneer Press Co	Advertising	1.80
12186	Daily News Publishing Co	Advertising	.90
12187	Brown, Treacy & Sperry Co	Stationery	6.62
12188	R. J. Maybell Stationery Co	Stationery	1.88
12189	Wyckoff, Seamans & Benedict	Stationery	5.85
12190	Farwell, Ozmun, Kirk & Co	Nails, etc	9.91
12191	Western Suppply Co	Pipe and fittings	48.97
12192	Crane & Ordway Co	Hose, pipe fittings, etc	23.62
12193	H. P. Rugg & Co	Pipe fittings	2.39
12194	Scribner-Libby Co	Roll felt	1.10
12195	Robinson & Cary Co	Belting, pipe fittings, etc	20.67
12196	Adam Decker & Co	Lanterns, oil cans, etc	8.50
12197	The Diebold Safe & Lock Co	Repairing vault door	1.00
12198	Tierney & Co	Feed	1.00
12199	Foley Bros. & Kelly Mercantile Co	Tea lead, candles, etc	53.45
12200	Nicols, Dean & Gregg	Machine bolts	1.23
12201	Ryan Drug Co	Lard oil	.55
12202	Standard Oil Co	Cylinder oil	18.61
12203	Engineering Dept. City of St. Paul	Road roller	15.00
12204	Fred Schroeder	Livery	18.00
12205	Boeringer & Son	Repairing transit	24.50
12206	Wm. J. Wagner	4-inch cast iron pipe	27.74
12207	Chas. Friend & Son	Harness repairs	.45
12208	Jos. R. Weide	Erroneous frontage tax	3.30
12209	Olson & Hawkins	Horseshoeing	6.00
12210	Schoch & Burningham	Kleansall, etc	2.25
12211	Cornplanter Oil Co	Estimate No. 19, oil	52.16
12212	Frank L. Gregory	Estimate No. 18, fuel	1,077.28
12213	Robert W. Hunt & Co	Inspecting pipe	42.36
12214	South Park Foundry & Machine Co	Estimate No. 3, fire hydrants	193.50
12215	Wm. Haas & Co	Photos of Electrolysis	49.85
12216	The Globe Co	Advertising	1.00
12217	Scribner-Libby Co	Repairs to engine	3.85
12218	C. Collins	Sharpening tools	11.95
12219	Arnold Uhler	Sharpening tools	2.80
12220	City of St. Paul, Engineering Dept	Relaying pavement	11.07
12221	John Caulfield	Bills paid per voucher	84.41
12222	Martin Feist	Lunch for men cleaning conduit	5.00
12223	South Park Foundry & Machine Co	Estimate No. 7, special castings	50.37
			$26,156.54

LIST OF VOUCHERS—*Continued.*

NOVEMBER, 1901.

No. of Voucher.	Name.	Claim.	Amount.
12224	John Caulfield, secretary	Warranty deed from Alex. Cardinal for 31 93-100 acres in Secs. 2 and 11, T. 31, R. 22	$798.25
12225	Otto Bremer, city treasurer	To interest on $350,000.00 due Oct. 1, 1901	7,000.00
12226	South Park Foundry & Machine Co	Gear wheels and pattern work.	7.05
12227	Gribben Lumber Co	Lumber for meter boxes, etc	24.75
12228	Lefebvre Roofing & Cornice Co	Ventilator for Vadnais station	22.00
12229	Jacob Lauer	Crushed stone for boiler foundation	39.00
12230	Board of Fire Commissioners	Old hose	19.60
12231	Eliza Luck	Overcharge on connection	3.85
12232	Ogden, Merrill & Greer	Lantern fittings	.76
12233	L. L. May	Lawn grass	1.00
12234	Union Water Meter Co	Meters	180.00
12235	Otto Bremer, city treasurer	Sewer assessment Fairview avenue	53.00
12236	Melbye & Co	Spring wagon for reservoir man	23.00
12237	Thomas Brennan Lumber Co	Lumber for pumping stations	57.00
12238	Pioneer Press Co	Letter heads	8.00
12239	Frank L. Gregory	Estimate No. 19, fuel	194.17
12240	Otto Bremer, city treasurer	Pay roll for October	7,526.47
12241	U. S. Cast Iron Pipe & Foundry Co	Estimate No. 4 and final, pipe	491.56
12242	James B. Clow & Sons	Estimate No. 1 and final, pipe	2,791.86
12243	James Shiely	Estimate No. 3, drayage	62.20
12244	F. L. Gregory	Estimate No. 20, fuel	150.09
12245	Geo. Weitbrecht	Chemical analysis	300.00
12246	Aug. Lundgren	Papering and painting office	125.00
12247	Twin City Fence & Wire Works	Shelves for vault	13.65
12248	Northwestern Stamp Works	Lead seals	1.25
12249	J. G. Duggan	Sharpening tools	7.30
12250	George Regelsberger	Plumbing and gas fitting	117.58
12251	South Park Foundry & Machine Co	Estimate No. 8, special castings	50.74
12252	Kate R. Thomas	Refund on street connection	4.00
12253	Otto Bremer, city treasurer	For sinking fund	10,000.00
12254	Standard Oil Co	Oil	3.28
12255	Wm. Kennedy Printing Co	Job printing	4.60
12256	Farwell, Ozmun, Kirk & Co	Hardware	7.90
12257	Cornplanter Oil Co	Estimate No. 20, oils	44.27
12258	Mitsch Wagon & Carriage Co	Two Concord buggies	269.65
12259	Albert Rehbein	Hauling oil to Centerville	2.00
12260	Wm. Haas & Co	Photo of map on electrolysis	27.00
12261	Chas. Quinn	Horseshoeing	4.00
12262	N. W. Shot & Lead Works	Pig lead	109.69
12263	Olson & Hawkins	Horseshoeing	4.00
12264	Griggs Bros.	Oats	60.44
12265	Prendergast Bros.	Elbow for boiler office	.75
12266	St. Paul Lime & Cement Co	Sewer brick	5.00
12267	Adam Decker & Co	Nails, felt, etc	16.40
12268	Wyckoff, Seamans & Benedict	Typewriter paper	1.40
12269	John Martin Lumber Co	Lumber	149.00
12270	D. L. Bell	Cement and lime	10.55
12271	Allan Black Co	Repairing steam plant	15.29
12272	Chas. Friend & Son	Harness fittings	4.15
12273	Brown, Treacy & Co	Stationery	19.60
12274	M. J. O'Neil	Mantles and tapers	4.40
12275	T. L. Blood & Co	Varnish	1.30
12276	Noyes Bros. & Cutler	Feather dusters	2.25
12277	R. J. Maybell Stationery Co	Stationery	27.33
12278	Nicols, Dean & Gregg	Tool steel	.81
12279	Foley Bros. & Kelly Merc. Co	Matches, candles, etc	14.35

LIST OF VOUCHERS—NOVEMBER, 1901—*Continued.*

No. of Voucher.	Name.	Claim.	Amount.
12280	Robinson & Cary Co	Jute packing, pipe fittings, etc	8.91
12281	Western Supply Co	Galvanized pipe, etc	67.80
12282	Crane & Ordway Co	Pipe fittings	15.96
12283	Crane & Ordway Co	Estimate No. 5, brass goods	122.94
12284	Chas. D. Gilfillan	Rent of storage lot	25.00
12285	H. P. Rugg & Co	Pipe fittings	1.83
12286	Matt Stein	Horseshoeing	2.00
12287	Franklin Mach. Works	Sharpening drill	.75
12288	A. J. Stobbart	Expenses to Anoka	2.85
12289	H. G. Perske	Recording warranty deed	3.50
12290	C. E. Green	Abstracting	19.50
12291	National Meter Co	Meters	23.50
12292	South Park Foundry & Machine Co	Estimate No. 9, specials	44.79
12293	South Park Foundry & Machine Co	Estimate No. 4, hydrants	96.75
12294	John Caulfield	Bills paid as per voucher	104.45
12295	Allan Black	Refund on street connections	12.75
12296	Griggs Bros.	Hay	30.90
12297	Frank L. Gregory	Estimate No. 21, fuel	472.22
12298	Robert W. Hunt & Co	Inspecting pipe	30.86
12299	Wm. F. Porten	Estimate No. 3, pump house, Vadnais Lake	4,348.25
			$36,318.05

DECEMBER, 1901.

12300	Otto Bremer, city treasurer	Pay roll for November, 1901	$6,287.48
12301	John Kenny	Estimate No. 1 and final, boiler	449.50
12302	A. P. Smith Mfg. Co	Pipe fittings	220.00
12303	Pittsburg Meter Co	Estimate No. 7, meters	133.14
12304	Union Meter Co.	Meter fittings	95.70
12305	South Park Foundry & Machine Co	Estimate No. 10, special castings	29.11
12306	South Park Foundry & Machine Co	Estimate No. 5, fire hydrants	96.75
12307	N. W. Shot & Lead Works	Lead pipe	109.44
12308	McCormick Harvester Machine Co	Refund on connection	22.82
12309	St. Paul Lime & Cement Co	Cement pipe	18.44
12310	Pioneer Press Co	Warrant book	14.75
12311	N. McEachran	Repairing private telephones	3.60
12312	Geo. Regelsberger	Plumbing	66.30
12313	Frank L. Gregory	Estimate No. 22, fuel	55.75
12314	Fred Stanley	Carpenter work	69.84
12315	A. Decker & Co	Hardware	11.92
12316	J. G. Duggan	Sharpening tools	6.45
12317	Jas. Shiely	Estimate No. 4 and final, drayage	50.56
12318	Pittsburg Meter Co	Estimate No. 8, meters	647.00
12319	South Park Foundry & Machine Co	Castings for Vadnais station	14.88
12320	People's Ice Co	Ice for office	8.00
12321	St. Paul Machine Works	Drilling 2 cast iron flanges	5.25
12322	McKibbin, Driscoll & Dorsey	Buggy robe	8.50
12323	Prendergast Bros.	Stove pipe	.90
12324	Leon St. Marie	Board of 2 monthly men	21.58
12325	Thos. Brennan Lumber Co	Lumber	2.12
12326	Martin Feist	Lunch for men repairing main	2.00
12327	Brown, Treacy & Sperry Co	Stationery	8.04
12328	Ramaley Publishing Co	Printing	.90

LIST OF VOUCHERS—DECEMBER, 1901—*Continued.*

No. of Voucher.	Name.	Claim.	Amount.
12329	The Globe Co.	Advertising	7.92
12330	Henry E. Wedelstaedt & Co.	Stationery	1.50
12331	Matt Stein	Horseshoeing	3.50
12332	T. L. Blood & Co.	Paint	2.20
12333	Allan Black Co.	Gas lamp fittings	4.50
12334	St. Paul Hardware Co.	Tools	.94
12335	Western Supply Co	Pipe, waste, etc.	48.26
12336	N. W. Shot & Lead Works.	Lead pipe	21.09
12337	D. L. Bell	Cement, fire brick, etc.	35.25
12338	The Ryan Drug Co.	Flax seed, etc	5.66
12339	H. P. Rugg & Co.	Pipe fittings, etc	5.26
12340	Foley Bros. & Kelly Co.	Matches, candles, etc.	28.83
12341	Crane & Ordway Co.	Pipe fittings	84.10
12342	Robinson & Cary Co.	Packing, tools, etc.	18.59
12343	E. P. Bassford.	Plans and specifications, Vadnais pump house	302.57
12344	St. Paul Sash, Door & Lumber Co	Lumber for hydrant boxes.	22.50
12345	Chas. Quinn	Horseshoeing	2.00
12346	R. J. Maybell Stationery Co.	Stationery	6.46
12347	Olson & Hawkins	Horseshoeing	2.00
12348	Adam Decker & Co.	Hardware	1.10
12349	Fred Schroeder	Livery	57.00
12350	F. R. Mann & Son.	Glass	1.05
12351	Ogden, Merrill & Greer.	Glasses and burner.	.69
12352	Cornplanter Oil Co.	Estimate No. 12, oils.	48.41
12353	Arnold Uhler	Sharpening tools	2.05
12354	St. Paul Fire & Marine Ins. Co.	Insurance	21.50
12355	C. D. Gilfillan	Rent of storage lot	25.00
12356	Nicols, Dean & Gregg.	Iron	15.04
12357	John Caulfield	Bills paid as per receipts attached	99.86
12358	C. Neumann	Meals for board on inspections.	94.20
12359	Geo. Regelsberger	Plumbing and gas fittings.	54.74
12360	Anna Collins	Sharpening tools	.90
			$9,484.79
		Grand total	$296,867.03

SUPERINTENDENT'S REPORT.

ST. PAUL, MINN., Jan. 1, 1902.

To the Board of Water Commissioners, St. Paul, Minn.,

GENTLEMEN: I herewith submit my annual report of work done by and under your direction for the year 1901.

The amount and character of the work done is shown by the accompanying tables:

14,884.8 lineal feet of water pipe laid on high service.
2,699 lineal feet of water pipe laid on low service.
1,924 lineal feet of water pipe laid on high service, West Side.

19,507.8 total lineal feet, or 3.6949 miles.

WATER MAINS RELAID DURING THE YEAR 1901.

595 lineal feet of water pipe relaid on low service.

20,102.8 grand total lineal feet pipe laid and relaid, or 3.8073 miles.

In addition to this mileage there were 3,667.2 lineal feet, or 0.695 miles laid inside of the Minnesota State Fair Grounds property. This being private property, the cost of material and labor was paid by the state to this department. It was not included in the mileage.

The number of fire hydrants placed during the year	25
The number of valves placed during the year	15
The number of service pipe connections	820
The number of automatic fire extinguishers	14

FIRE HYDRANTS.

There have been twenty-five hydrants placed during the year, which make a total of 2,346 that are now in service. There were also eight hydrants put inside the State Fair Grounds besides the above-mentioned number of 2,346.

There were 964 hydrants upon which a repair of some kind was made. One hundred and seventeen hydrants were affected by frost, requiring the use of steam in thirty-nine of them in order to put them in proper shape. Four hydrants were changed. For location of same, see table No. 6.

STREET SPRINKLING STAND-PIPES.

There were seven new stand-pipes placed during the year, the total number now in service being 316. There were 216 separate repairs, nineteen of which were the 2-inch stand-pipes split from frost. There were seventeen Crane attachments placed on fire hydrants as a temporary supply for sprinkling carts, all of which were removed on or about Nov. 5, 1901.

REPAIRS ON MAINS.

There have been sixteen leaks repaired on mains during the year, the cost for labor on same being $481.24, and for material $113.13, making a total of $594.37.

VALVES PLACED IN REPAIRS.

There were fifteen valves placed during the year, making a total of 2,202 valves up to date. There were seventy valves repaired during the year, the repairs being of such nature incident to their general maintenance.

AUTOMATIC FIRE EXTINGUISHERS.

There were fourteen new automatic fire extinguishers placed during the year, which makes a total of fifty having been placed up to date.

SERVICE PIPE CONNECTIONS.

There have been 820 service pipes put in during the year, making a total up to date of 17,913. Seventeen frozen pipes have been repaired and 123 leaks in services repaired.

TEMPORARY MAINS.

There were 3,101 lineal feet of temporary mains laid during the year, making a total of 19,759 lineal feet laid up to date, or 3.742 miles.

PUMPING STATIONS.

During the year a new brick pumping station was built at Vadnais lake, at a total cost, including boilers, setting boilers and other work connected with it, of $10,495.88.

SUMMARY OF RECOMMENDATIONS.

In the recommendations of work to be done during the year 1902, I would respectfully suggest for your consideration the following:

Lay a 16-inch main for supply on Maryland street from Cortland to McMenemy street, and a 12-inch main on McMenemy street from Maryland to Geranium street, to be used as a cross-feeder for the high service

district of Arlington Hills and Dayton's Bluff. The necessity of this is very apparent, as the districts above referred to depend solely upon the 16-inch main on Grove street and Seventh street, and in case of accident to the main all the northern and eastern portion of the city would be out of water until the main was repaired. The estimated cost of this work would be $10,900.

The district bounded by Seventh street, Broadway, Fourth and Kittson streets should be rearranged by relaying of all 4-inch mains with 6-inch and 8-inch mains, and by laying the following cross-feeder:

A 12-inch main on Locust street from Seventh street to Fourth street. As this district is building up very rapidly with packing houses and warehouses, the necessity of the above is very apparent.

The relaying of the following old cement pipes with 6-inch cast iron pipe: Canada street from Ninth street to Spruce street; Canada street from Norris street to Grove street; Monroe place from Grove street to Woodward avenue.

The dam at Peltier lake ought to be completed, and such other work as raising the roadway around the shore line should be done this coming year.

The embankment between the west arm of Vadnais lake and Vadnais lake proper should be sheeted with 2-inch matched lumber and an embankment made of clay to prevent the water leaking through. The embankment on the south end of Vadnais lake should be raised to the extent of two or three feet.

A gasoline engine should be put in at the West Side pumping station, as at present only one engine is there, and in case of breakage to this pump the entire West St. Paul high service will be without water during the time necessary for repairing this engine.

Respectfully submitted,

JNO. LINDQUIST,

Superintendent.

TABLE NO. 1.

PIPE LAID ON HIGH SERVICE DURING THE YEAR 1901.

Date.	Street.	From	6 inch.	12 inch.
July 5	Conway	Maria to 253 feet west of west line of Maria	253	
Aug. 3	Snelling	Old G.N. Ry. right of way to Atlantis		4,185.8
Aug. 26	Van Buren	Hamline to Simpson	1,767	
Aug. 30	Burgess	Kent to Dale	738	
Sept. 4	Pacific	Hester to 600 feet east of Hester	600	
Sept. 18	De Soto	Lawson to Cook	337	
Sept. 24	Grand	Milton to Chatsworth	538	
Sept. 28	Chatsworth	Carroll to Rondo	312	
Sept. 28	Carroll	Across Chatsworth	46	
Oct. 2	Selby	Wilder to Cleveland	396	
Oct. 4	Pelham	410 feet south of University to a point 191.9 south of south line of Franklin	619	
Oct. 7	Bourne	Keston to 388 feet west of Keston	388	
Oct. 14	County Road	Carter to Buford	1,353	
Oct. 14	Carter	Across County Road	50	
Oct. 17	Marion	Front to Lawson	692	
Nov. 6	Laurel	Oxford to Lexington	647	
Nov. 11	Park	Viola to Como	389	
Nov. 13	Hatch	Oxford to Churchill	258	
Nov. 21	Dooley	Keston to County Road	1,134	
Nov. 21	Keston	Across Dooley Ave	82	
		Totals	10,699	4,185.8

	Feet.
Total 6 inch pipe	10,699
Total 12 inch pipe	4,185.8
Total on high service	14,884.8 feet or 2.819 miles.

REMARK:—In addition to the above mentioned extensions on high service there has also been laid the following mains inside the Minnesota State Fair grounds, and which is not included in the mileage:

	Feet.
6 inch pipe	1,367
8 inch pipe	2,300.2
Total	3,667.2 feet or 0.695 mile.

TABLE NO. 2.

PIPE LAID ON LOW SERVICE DURING THE YEAR 1901.

Date.	Street.	From	6 inch.
Feb. 28	Michigan	West Seventh to Richmond	570
April 11	Richmond	West Seventh to railroad	194
Aug. 6	Sturgis	Douglas to Garfield	660
Nov. 1	Tuscarora	Milton to Chatsworth	661
Dec. 3	Levee	Broadway to 614 feet east	614
		Total	2,699

Total on low service ..... 2,699 feet or 0.511 mile.

TABLE NO. 3.

PIPE LAID ON WEST SIDE HIGH SERVICE DURING THE YEAR 1901.

Date.	Street.	From	6 inch.
Oct. 22.....	Robie.....	Ohio to Orleans.....	587
Oct. 26.....	Smith.....	Baker to Stevens.....	740
Oct. 29.....	Stryker.....	Louisa to George.....	597
		Total.....	1,924

Total of West Side high service..... 1,924 feet or 0.365 mile.

TABLE NO. 4.

LOCATION, SIZE AND NUMBER OF FEET OF PIPE RELAID ON LOW SERVICE DURING THE YEAR 1901.

Date.	Street.	From	8 inch.	16 inch.
July 8.....	Eighth.....	Cedar to Minnesota, 376 feet 4 inch cast iron pipe relaid with 8 inch iron.....	376	.....
Sept. 29.....	Broadway.....	Across the Levee, 16 inch pipe relaid with 16 inch pipe, cause, heavy fill by R. R. Co.....	.....	219
		Totals.....	376	219

	Feet.
Total 8 inch pipe relaid.....	376
Total 16 inch pipe relaid.....	219
Total on low service.....	595 feet or 0.113 mile.

TABLE NO. 5.

SUMMARY OF WATER PIPE LAID IN THE CITY OF ST. PAUL, JANUARY 1, 1902.

System.	4 Inch.	6 Inch.	8 Inch.	12 Inch.	16 Inch.	20 Inch.	24 Inch.	30 Inch.	36 Inch.	Total Feet.	Total Miles.
High service	38,807	600,833.4/8	658	126,223.8	87,543.5	36,224	15,817	10,075	9,100	924,781.7	175.1480
Low service	35,539	194,885.5	6,732	51,444.0	40,620.0	8,342	8,765	16,436	18	362,781.5	68.7086
W. S. high service	.....	29,567.5	.....	7,530.0	3,950.0	.....	.....	.....	.....	41,047.5	7.7741
Total	74,346	825,286.4	7,390	185,197.8	132,113.5	44,566	24,082	26,511	9,118	1,328,610.7	251.6307

	Feet
Total 4-inch pipe	74,346.0
Total 6-inch pipe	825,286.4
Total 8-inch pipe	7,390.0
Total 12-inch pipe	185,197.8
Total 16-inch pipe	132,113.5
Total 20-inch pipe	44,566.0
Total 24-inch pipe	24,082.0
Total 30-inch pipe	26,511.0
Total 36-inch pipe	9,118.0
Grand total	1,328,610.7 feet, or 251.6307 miles.

TABLE NO. 6.

HYDRANTS PLACED IN 1901.

Hydrant No.	Location.	Service.	Double or Single Steamer.	Size of Hydrant Branch.	Pressure at Hydrant.
2322	Michigan and Richmond, n. e. corner..	Low.....	Single.....	6-inch.....	34
2323	Richmond and Milwaukee R. R.....	W. S. low	Single.....	6-inch.....	39
2324	Hampden, bet. Territorial road and Ellis.....	W.S. high	Single.....	6-inch.....	47
2325	N. s. Conway, 233 feet w. of Maria av...	High	Single.....	6-inch.....	31
2326	Van Buren and Pascal, n. w. corner....	High	Single.....	6-inch.....	30
2327	Van Buren and Albert, n. w. corner...	High	Single.....	6-inch.....	31
2328	Van Buren and Hamline, n. w. corner.	High	Single	6-inch.....	32
2329	Cook and De Soto, s. w. corner.....	High	Single	6-inch.....	41
2330	N. s. Pacific, bet. Hester and Griffith..	High	Single	6-inch.....	22
2331	Grand and Chatsworth, n. e. corner....	High	Single	6 inch.....	40
2332	Chatsworth and Rondo, n. w. corner...	High	Single	6-inch.....	48
2333	Selby and Wilder, n. w. corner.....	High	Single	6-inch.....	47
2334	N. s. Bourne, 388 ft. w. of w.l. of Keston	High	Single	6-inch.....	20
2335	Doswell and County road, s. w. corner..	High	Single	6-inch.....	26
2336	Pierce and County road, s. w. corner..	High	Single	6-inch.....	25
2337	Buford and County road, s. w. corner..	High	Single	6-inch.....	32
2338	Marion and Hatch, n. w. corner.....	High	Single	6-inch.....	60
2339	Marion and Lawson, n. w. corner.....	High	Single	6-inch.....	56
2340	Smith and King, n. w. corner.....	W.S. high	Single	6-inch.....	50
2341	Stryker & Dearborn, n. w. corner.....	W.S. high	Single	6-inch.....	89
2342	Stryker and Louisa, n. w. corner.....	W.S. high	Single	6-inch.....	86
2343	Tuscarora and Chatsworth, n. e. corner	Low.....	Single	6-inch.....	29
2344	Laurel and Lexington, n. e. corner.....	High	Single	6-inch.....	39
2345	Hatch and Oxford, n. w. corner.....	High	Single	6-inch.....	36
2346	W. s. Broadway and Levee.....	Low.....	Single	6-inch.....	69
1588	Minnehaha and Duluth Ry. was changed from single to double steamer.....	High	Double	6-inch.....	.....
1589	Minnehaha and Greenbrier was changed from single to double steamer.....	High	Double	6-inch.....	.....
110	Sibley and Levee was removed from the n. w. corner to the n. e. corner of same streets.....	Low.....	Single	4-inch.....	.....
2295	Was removed from Pelham, 410 feet s. of University, to Pelham and Franklin, n. w. corner.....	High	Single	6-inch.....	.....

New fire hydrants placed during the year 1901 on high service	18
New fire hydrants placed during the year 1901 on low service	4
New fire hydrants placed during the year 1901 on West Side high service	3
Total for the year.....	25

REMARK.—There were 8 single steamer fire hydrants put in inside the Minnesota State Fair Grounds during the year, in addition to the above mentioned 25.

TABLE NO. 7.

VALVES PLACED IN 1901.

Street.	Service.	Location.	6 Inch.	8 Inch.	12 Inch.	16 Inch.
Conway	High	West line of Maria	1			
Eighth	Low	East line of Cedar*		1		
Sturgis	Low	East line of Garfield	1			
Snelling	High	65 ft. south of G. N. R. R. bridge			1	
Snelling	High	South line of Langford			1	
Snelling	High	952.8 ft. n. of n. line of Langford		1		
Selby	High	East line of Cleveland	1			
County Road	High	North line of Carter	1			
Marion	High	North line of front	1			
Marion	High	North line of Lawson	1			
Smith	W. S. H.	North line of Baker	1			
Park	High	South line of Como	1			
Dooley	High	West line of County Road	1			
Broadway	Low	On Levee near Union Depot	1			
Broadway	Low	On Levee near Union Depot	1			
		Totals	11	2	2	

Total on high service 10
Total on low service 4
Total on west side high service 1

Grand Total 15

Remark—In addition to the above, there were placed inside of the Minnesota State Fair Grounds:
8 inch valves, 2.
6 inch valves, 3.

* The four inch valve has been taken out and an 8 inch valve put in its place, when main was changed from 4 inch to 8 inch.

TABLE NO. 8.

TOTAL NUMBER OF VALVES ON ALL SYSTEMS, JAN. 1, 1902.

SIZES IN INCHES.	Low Service.	High Service.	West Side High Service.	Total.
2 inches.....Blow-offs	4	1	.....	5
3 inches.....	16	23	.....	39
4 inches.....	114	118	.....	232
6 inches.....	455	988	44	1,487
8 inches.....	27	3	.....	30
12 inches.....	77	139	8	224
16 inches.....	39	67	5	111
20 inches.....	10	33	.....	43
24 inches.....	5	9	.....	14
30 inches.....	5	6	.....	11
36 inches.....	1	5	.....	6
Totals.....	753	1,392	57	2,202

TABLE NO. 9.

STREET SPRINKLING STAND PIPES PLACED DURING THE YEAR 1901.

No.	LOCATION.	Measurement of Valve from Stand Pipe.
310	Arcade and Lawson, n. e. corner.....	32 feet.
311	Snelling and Breda, n. w. corner.....	7 feet.
312	Snelling and Atlantis, s. w. corner.....	9½ feet.
313	Simpson and Capitol, n. w. corner.....	6 feet.
314	Sheldon and Capitol, n. w. corner.....	8 feet.
315	Earl and Thorn, n. w. corner.....	6 feet.
316	King and Ohio, s. w. corner.....	31 feet.
100	Was removed from Summit Place and Martin to Weide and Case, s. w. corner.....	63 feet north, 9 feet east.
90	Was removed from Virginia and University, n. w. corner, to the n. e. corner of same streets.....	33 feet west, 13 feet south;
66	Locust and Ninth, was extended further out into the street 2 feet, cause setting of curb stone.....	second valve 46 feet south.
194	Dale and Charles, was removed 100 feet s. of Charles..	3 feet.
171	Was removed from Van Buren and Snelling to Minnehaha and Holton, n. e. corner.....	7 feet.
216	Was removed from Sycamore Jackson to Sycamore and Lightner Place, s. w. corner.....	6 feet.
228	Oxford and Summit, removed from n. e. corner to s. w. corner of same streets.....	93 feet north, 27 feet east.

Number placed this year..... 7
Total number placed to date..... 316

TABLE NO. 10.

LOCATION, SIZE AND NUMBER OF FEET OF WATER MAINS LAID ON HIGH SERVICE TO JAN. 1, 1902.

STREET.	From Street to Street.	4-Inch.	6-Inch.	12-Inch.	16-Inch.	20-Inch.	24-Inch.	30-Inch.	36-Inch.
Arlington	Greenbrier to Payne	650							
Arundel	Summit to Lafond	2553							
Ashland	Western to Oxford		7203						
Aurora	Robert to Chatsworth		7814						
Arcade	Third to Rose		1070	5382					
Astoria	St. Anthony to Milwaukee		275						
Argyle	Front to Van Slyke	370	831						
Albemarle	Atwater to Front	1293							
Arch	100 feet west of Columbia to Rice		2286						
Atlantic	Fauquier to Stillwater		1785						
Atwater	Dale to Sylvan		1261						
Agate	Cortland to Jenks		2437						
Avon	Dayton to Martin	1381							
Asbury	Van Buren to Blair		307						
Arkwright	Jessamine to Magnolia		327						
Beaumont	De Soto to Payne		1881						
Bedford	North to Minnehaha		1327						
Bradford	Hampton to 75 feet east of Endicott		894						
Bradley	North of Maryland		256						
Bradley	Beaumont to Minnehaha	498							
Bates	Maury to Hastings		376	3035					
Beech	Seventh to Atlantic		4407						
Blair	Western to Fairview		4610						
Broadway	Thirteenth to Mt. Airy		407		533				
Burr	Collins to Brainerd		5183						
Burgess	Dale to Como		852						
Bayless av	Raymond to Langford Park				2935				
Bayless pl	Raymond to Bayless a.	902							
Burns	Mound to Griffith		2753						
Blake	Raymond to Langford P. P. E.		282		186				
Beacon	University to Shields	594							
Bourne	Keston to Eustis		388						
Buffalo	Capitol to Granite		631						
Canada	University to Valley		290						
Capitol	Mississippi to Fairview		6866						
Carroll	Rice to Cleveland		13248						
Cedar	Summit to Como		2486						
Central av	East line of Central Park to Rice	557	1254						
Cent'l P. pl.. E. and W	Summit to Central	1209							
Charles	Rice to Vandalia		10235.3						
Capitol boul	University to Como		1076						
Cable	Seventh to Margaret			650					
Cook	Forest to Rice		6967						
Conway	Earl to Hoffman		3980						
Churchill	Front to Van Slyke	1103	1263						
College	Rice to Third		1165						
Como boul	East line of lot 4, block 5, to north line of lot 5, block 1, Warrendale		666						
Como av	Park to Dale				512.5	6555			
Chelton	Prior to Tatum		559						
Cherry	200 feet west of Hoffman to Maria	230	565						
Case	Forest to Terrace		345	6551					
Claghorn	Lafond to Van Buren		628						
Cypress	North to Euclid	45							
Cromwell	Manvel to Cudworth		1599						

WATER MAINS ON HIGH SERVICE—*Continued.*

STREET.	From Street to Street.	4-Inch.	6-Inch.	12 Inch.	16-Inch.	20 Inch.	24-Inch.	30-Inch.	36-Inch.
Cudworth	Bayless to Eustis		985						
Clark	Whitall to Case		1308						
Cross	Argyle to Lexington		966						
Cambridge	Princeton to Lincoln		1060						
County rd	Scudder to Buford		1353		256				
Crocus pl	Goodrich to Fairmount	1314							
Chatsworth	Evergreen to Van Slyke		1295						
Cleveland	Lincoln to University			3411	3313				
Cortland	Capitol to Maryland		252		4600				
Cayuga	Mississippi to Cortland		1630						
Carter	West line lot 31, block 40 to County road		1936						
Collins	Lafayette to Bedford		1016						
Dale	Fairmount to Reservoir	4800		2110	5280	1453	14500	9234	1560
Dayton	Third to Cleveland	192	11578	4675					
Duluth	Seventh to Omaha Ry		434						
Dayton pl	West to Maria	275							
Dawson	Arcade to Gotzian		3673						
Dooley	Keston to 15 feet east of Raymond		2461						
De Soto	North to Cook		4120						
Decatur	Bedford to Beaumont		710						
Earl	Thorn to Magnolia		8.5	4083	2603				
Edmund	Rice to Milton		8518						
Eichenwald	Sixth to Seventh		532						
Euclid	Maple to Earl		2391						
Elfelt	Charles to Blair	1034							
Everett ct	Wheeler to Great Northern Ry		355						
Edgerton	Minnehaha to Maryland		328	4272					
Ellis	Territorial road to Hampden		1841						
Fuller	Rice to Lexington		8548.3						
Farrington	Summit to Lafond		3459						
Fauquier	290 feet east of Atlantic to Greenbrier		6153						
Fifth	125 feet east of Hoffman to Maple		1543						
Floral	Summit to Oakland	518							
Fourth	Terry to 400 feet west of Maria		5342						
Front	Sylvan to Lexington		1140	10475	12	12			
Fairmount	Dale to Milton		2931	518					
Fairview	Valley to 200 feet north of Mt. Airy		578						
Feronia	Fairview to Prior		1378						
Fremont	Farl to Arcade		2577						
Fairview av	Selby to Capitol			2542	1971				
Fry	Territorial rd.to Capitol	1087	6						
Frank	Margaret to Minnehaha		652						
Frances	Mendota to Cypress		1927						
Fred	Burr to Bedford	337							
Forest	Conway to Rose		3492						
Forcemain	Pumphouse to Reservoir					7886	46	70	7386
Flandrau	Harvester to Stillwater		595						
Grand	Lawton to Cretin		9950						
Grove	Seventh to Pine				2618				
Grotto	Lincoln to Lafond		4594						
Goodrich	782 feet east of Dale to Oxford		5358						
Greenbrier	Arlington to Magnolia	512	332						
Gaultier	Sherburne to Geranium		3671						
Gordon	Raymond to Carter		1387	635					
Genesee	Mississippi to Buffalo		814						
Granite	Mississippi to Cortland		1022						

WATER MAINS ON HIGH SERVICE—*Continued.*

STREET.	From Street to Street.	4-Inch.	6-Inch.	12-Inch.	16-Inch.	20-Inch.	24-Inch.	30-Inch.	36-Inch.
Geranium	Park to Cypress		6315.5						
Hoffman	Clearmont to Seventh		2946						
Holly	Western to Victoria		5287						
Hague	Dale to Griggs		6512						
Hudson	Cypress to Maria		2389	194					
Hastings	Bates to Hester			3066					
Hewitt	Aldine to Syndicate		4541						
Hope	Fourth to Seventh		1156						
Hampden	Raymond to Territorial road*		1733						
Hatch	Churchill to Sylvan		930						
Harvester	White Bear to Hazel			1303					
Hazel	Harvester to 300 feet north of Ames			980					
Horton	Van Slyke to Como b'l'd		419						
Hardenbergh place	Lyton place to Atwater	349							
Iglehart	Wabasha to Cleveland		14706						
Jackson	Viola to Sycamore		236	2237	145				
Jay	St. Anthony to Fuller		656						
Jenks	Forest to Cortland		6084						
Jessamine	Rice to Cypress		8830						
Jessie	Minnehaha to Maryland		3269						
Knapp	Langford to Raymond		1838						
Keston	Dooley to Doswell		1006						
Kent	Portland to Carroll	2201							
Kenwood Pk	St. Albans around said park		767						
Laura	Waltham to University		1211						
Laurel	Nina to Lexington		8944						
Lawton	Grand to Summit		480						
Lawson	Earl to Rice		8686						
Lincoln	Oakland to Finn		8390						
Louis	Nelson to Fuller		2122						
Linden	Mt. Airy to Arch		696						
Lafond	Rice to Milton		7340						
Lynnhurst E. and W.	University to Feronia		1850						
Lexington	Grand to Van Slyke				3818				
Langford P. P. E.	Bayless to Knapp		415		427				
Langford P. P. W.	Bayless to Gordon		181	670					
Langford av.	Scudder to Dooley			1236	838				
Lookout pl	Arkwright to Westminster		447						
Litchfield	Rice to Sylvan		1142						
Leslie	Victoria to Chatsworth		1256						
Lombard	Milton, 454 feet west		454						
Linwood pl	Osceola to Lexington		2621						
Lyton pl	Rice to Sylvan		1142						
Lake Como & Phalen av.	At Dale street			23					
Mackubin	Summit to Edmund		5706						
Maple	Hastings to Seventh		2660	811					
Margaret	Gotzian to Greenbrier		4782						
Martin	Central to Milton		7739						
Maria	River to North		5481						
Marshall	Western to N. Cretin		3378.5	10506					
Magnolia	120 feet east of Mississippi to Cypress		5717						
Marion	University to Lawson		3630						
Minnehaha	Duluth to Tatum		6071	7473					
McLean	Maria to Hester		1395						
Mendota	Hudson to Fauquier		655	3286					
Mt. Airy	L'Orient to Robert		2024						
Maryland	Dale to Arcade		3855	22					

*Also 658 feet of 8-inch pipe.

WATER MAINS ON HIGH SERVICE—*Continued.*

STREET.	From Street to Street.	4-Inch.	6-Inch.	12-Inch.	16-Inch.	20-Inch.	24-Inch.	30-Inch.	36-Inch.
Mound	Hastings to 335 feet west of Earl	.....	1298	1536	.....	.....	.....	.....	.....
Milwaukee	Merriam Pk. to Astoria	.....	570	.....	.....	.....	.....	.....	.....
Manvel	Robbins to Raymond	.....	1142	.....	.....	.....	.....	.....	.....
Mulberry	Third to Sixth	435	.....	.....	.....	.....	.....	.....	.....
Milford	Rice to Woodbridge	.....	655	.....	.....	.....	.....	.....	.....
Minneapolis	At Dale	.....	.....	18	.....	.....	.....	.....	.....
McMenemy	Case to Geranium	.....	.....	1986	.....	.....	.....	.....	.....
Mississippi	Great Northern Ry. to Cayuga	.....	1136	.....	.....	.....	.....	.....	.....
Manitoba	Rice to Sylvan	.....	1139	.....	.....	.....	.....	.....	.....
Macalester	Summit to Princeton	.....	1885	.....	.....	.....	.....	.....	.....
Mt. Ida	De Soto to Rivoli	.....	535	.....	.....	.....	.....	.....	.....
Milton	Victoria to Lombard	.....	335.5	.....	.....	.....	.....	.....	.....
Nelson	Summit to Western	.....	2422	.....	.....	.....	.....	.....	.....
Nina	Summit to Selby	.....	800	.....	.....	.....	.....	.....	.....
North	De Soto to Seventh	.....	1886	.....	.....	.....	.....	.....	.....
Nourse	Gordon to N. P. Ry	.....	392	.....	.....	.....	.....	.....	.....
Oakland	Ramsey to Summit	.....	3662	.....	.....	.....	.....	.....	.....
Olive	Olmsted to Pennsylvania	.....	1057	.....	.....	.....	.....	.....	.....
Oakley	Lynnhurst w. to Prior	.....	451	.....	.....	.....	.....	.....	.....
Osceola	Pleasant to Chatsworth	.....	3709	.....	.....	.....	.....	.....	.....
Otsego	Lafayette to Mt. Ida	.....	791	.....	.....	.....	.....	.....	.....
Park pl	Park drive southwest	574	.....	.....	.....	.....	.....	.....	.....
Park av	Martin to Geranium	.....	5214.5	.....	.....	.....	.....	.....	.....
Princeton	Macalester to Baldwin	.....	1399	.....	.....	.....	.....	.....	.....
Pine	Grove to Pennsylvania	.....	1820	.....	387	.....	.....	.....	.....
Portland	Summit to Oxford	.....	5949	.....	.....	.....	.....	.....	.....
Pennsylvania	Rice to Pine	505	342	.....	.....	.....	.....	.....	.....
Pelham	University to Wabash	.....	1039	.....	.....	.....	.....	.....	.....
Preble	Beaumont to Minnehaha	.....	471	.....	.....	.....	.....	.....	.....
Payne	Beaumont to Ivy	.....	6791	.....	.....	.....	.....	.....	.....
Plum	Maple to Hoffman	.....	1150	.....	.....	.....	.....	.....	.....
Prior	Selby to University	.....	804	3447	.....	.....	.....	.....	.....
Pascal	Minnehaha to Taylor	.....	1743	.....	.....	.....	.....	.....	.....
Pym	Bayless to Eustis	.....	.....	736	.....	.....	.....	.....	.....
Priscilla	Raymond avenue east	.....	542	.....	.....	.....	.....	.....	.....
Pratt	Raymond to Gibbs	.....	762	.....	.....	.....	.....	.....	.....
Phalen	Seventh to Stillwater	.....	.....	1467	.....	.....	.....	.....	.....
Pacific	Cypress to Griffith	.....	1860	.....	.....	.....	.....	.....	.....
Pleasant	Osceola to St. Albans	.....	.....	569	.....	.....	.....	.....	.....
Poplar	N. P. R. R. yard to Cortland	.....	889	.....	.....	.....	.....	.....	.....
Rice	College to Jessamine	.....	1678	2147	5990	1154	.....	.....	.....
Robert	171 feet south of University to 254 north of same	.....	425	.....	.....	.....	.....	.....	.....
Rondo	Rice to Terrace Pk. av	.....	10061	.....	.....	.....	.....	.....	.....
Ramsey	Oakland to Summit	.....	1259	.....	.....	.....	.....	.....	.....
Ross	Atlantic to Seventh	.....	2467	.....	.....	.....	.....	.....	.....
Ravoux	Rondo to Fuller	616	.....	.....	.....	.....	.....	.....	.....
River	Maria to Hoffman	359	.....	.....	.....	.....	.....	.....	.....
Ravine	Maple to 344 feet west of Maria	1423	.....	.....	.....	.....	.....	.....	.....
Raymond	University to Buford	.....	4665	.....	1588	.....	.....	.....	.....
Robbins	Bayless to Raymond Pk	.....	440	.....	.....	.....	.....	.....	.....
Reaney	Edgerton to English	.....	7834	.....	.....	.....	.....	.....	.....
Rose	Edgerton to Cypress	.....	2573	.....	.....	.....	.....	.....	.....
Sherburne av	Dunlap to Jackson	400	11082	.....	.....	.....	.....	.....	.....
St. Anthony	Rice to Cleveland	.....	13893	.....	.....	.....	.....	.....	.....
St. Peter	College to University	.....	2557	.....	.....	.....	.....	.....	.....
Selby	Summit to Cleveland	.....	17398	.....	.....	.....	.....	.....	.....
Seventh	Grove to White Bear av	.....	.....	.....	15025	.....	.....	.....	.....
Sinnen	Sixth to Seventh	.....	541	.....	.....	.....	.....	.....	.....
Summit av	C. P. D. E. to Baldwin	913	5481	15284	.....	.....	.....	.....	.....
Summit pl	Nelson to Fuller	.....	2122	.....	.....	.....	.....	.....	.....
St. Albans	Pleasant to Martin	2366	300	556	.....	.....	.....	.....	.....

WATER MAINS ON HIGH SERVICE—*Continued.*

STREET.	From Street to Street.	4-Inch.	6-Inch.	12-Inch.	16-Inch.	20-Inch.	24-Inch.	30-Inch.	36-Inch.
Sims	Edgerton to Earl	.....	4539	.....	.....	.....	.....	.....	.....
Sum'it ct. a'y.	East of Lawton	.....	362	.....	.....	.....	.....	.....	.....
Short	Maria to Hoffman	.....	591	.....	.....	.....	.....	.....	.....
Snelling	Goodrich to Atlantis	.....	.....	4185.8	11195	.....	.....	.....	.....
Simpson	Blair to Hewitt	.....	1528	.....	.....	.....	.....	.....	.....
Sixth	Hoffman to Arcade	.....	2646	.....	.....	.....	.....	.....	.....
Sixth	College to Summit	.....	537	.....	.....	.....	.....	.....	.....
Sidney	Raymond to Ellis	.....	1225.5	.....	.....	.....	.....	.....	.....
Scudder	Blake to Langford	.....	.....	.....	1347	.....	.....	.....	.....
St. Clair	Victoria to Oxford	.....	.....	1935	.....	.....	.....	.....	.....
Stinson	Gaultier to Western	.....	1266	.....	.....	.....	.....	.....	.....
Sycamore	Rice to Cortland	.....	.....	2509	.....	.....	.....	.....	.....
Syndicate	Lincoln to Summit	.....	967	.....	.....	.....	.....	.....	.....
Stellar	Atwater to Lyton	.....	372	.....	.....	.....	.....	.....	.....
Shelton	Minnehaha to Wesley	.....	902	.....	.....	.....	.....	.....	.....
Stillwater	White Bear to Ames	.....	906	.....	.....	.....	.....	.....	.....
Summit ct.	Alley to Summit	260	.....	.....	.....	.....	.....	.....	.....
Suction main	Pumphouse to Ter. ch'r	.....	.....	.....	.....	.....	771	771	154
Taylor	Aldine to Holton	.....	2898	.....	.....	.....	.....	.....	.....
Tatum	Minnehaha to Chelton	.....	541	.....	.....	.....	.....	.....	.....
Third	Cypress to Summit	367	5290.5	.....	.....	.....	.....	.....	.....
Thirteenth	Pine to Broadway	.....	.....	.....	778	.....	.....	.....	.....
Tilton	Wabasha to Rice	.....	1278	.....	.....	.....	.....	.....	.....
Thomas	Como to Chatsworth	.....	7605	.....	.....	.....	.....	.....	.....
Topping	At Como and at Dale	.....	118	.....	.....	.....	.....	.....	.....
Territorial road	Raymond to Eustis	.....	1498	.....	.....	.....	.....	.....	.....
University	Broadway to Cromwell	.....	40	6387	3594	19164	.....	.....	.....
Valley	Broadway to Jackson	.....	.....	.....	1789	.....	.....	.....	.....
Viola	Jackson to Rice	.....	1653	.....	.....	.....	.....	.....	.....
Van Buren	Western to Wheeler	.....	8686	.....	.....	.....	.....	.....	.....
Victoria	St. Clair to Hatch	.....	.....	375	9518	.....	.....	.....	.....
Virginia	Summit to Como	2758	1798	.....	.....	.....	.....	.....	.....
Vandalia	University, north of Charles	.....	761.3	.....	.....	.....	.....	.....	.....
Van Slyke	Chatsworth to Lexington	.....	1438	.....	.....	.....	.....	.....	.....
Wabasha	Summit to Park	537	842	.....	.....	.....	.....	.....	.....
Western	Summit to Como	.....	.....	1775	6285	.....	.....	.....	.....
Williams	Olive to Mississippi	.....	857	.....	.....	.....	.....	.....	.....
Waltham	Laura to Prior	959	.....	.....	.....	.....	.....	.....	.....
Wayzata	At Albemarle	.....	90	.....	.....	.....	.....	.....	.....
Wilder	Iglehart to St. Anthony	.....	1388	.....	.....	.....	.....	.....	.....
Whithall	Payne to Clark	.....	2301	.....	.....	.....	.....	.....	.....
Walker	Hewitt to Great Northern Ry	807	.....	.....	.....	.....	.....	.....	.....
Wesley	Pascal to Fry	394	621	.....	.....	.....	.....	.....	.....
Workhouse	Around workhouse	.....	1043	.....	.....	.....	.....	.....	.....
Wheeler st.	Bayless to Everett	.....	.....	1012	.....	.....	.....	.....	.....
Westminster	Cayuga to Case	.....	999	.....	.....	.....	.....	.....	.....
Wheeler av.	University to Shields	.....	588	.....	.....	.....	.....	.....	.....
Woodbridge	Atwater to Rose	.....	3599	.....	.....	.....	.....	.....	.....
Winnipeg	Rice to Sylvan	.....	1142	.....	.....	.....	.....	.....	.....
Wells, N. S.	Edgerton to Arcade	.....	2090	.....	.....	.....	.....	.....	.....
Wells, S. S.	From E. to W. end of retaining wall	1130	.....	.....	.....	.....	.....	.....	.....
White Bear	Seventh to Ames	.....	.....	1992	.....	.....	.....	.....	.....
Wycliff	Bradford to Hampden	.....	700	.....	.....	.....	.....	.....	.....
York	Forest to Cortland	.....	5782	.....	.....	.....	.....	.....	.....
	Totals	38807	590134.4	122038	875435	36224	15317	10075	9100

	Feet.
Total 4-inch pipe	38,807
Total 6-inch pipe	600,833.4
Total 8-inch pipe (Hampden)	658
Total 12-inch pipe	126,223.8
Total 16-inch pipe	87,543.5
Total 20-inch pipe	36,224
Total 24-inch pipe	15,317
Total 30-inch pipe	10,075
Total 36-inch pipe	9,100
Total	**924,781.7 feet, or 175.1480 miles.**

TABLE NO. 11.

LOCATION, SIZE AND NUMBER OF FEET OF WATER MAINS LAID ON LOW SERVICE TO JAN. 1, 1902.

STREET.	From Street to Street.	4-Inch.	6-Inch.	8-Inch.	12-Inch.	16-Inch.	20-Inch.	24-Inch.	30-Inch.
Alabama	Crossing state	.....	55	.....	.....	.....	.....	.....	.....
Armstrong	Drake to Chatsworth	.....	3865	.....	.....	.....	.....	.....	.....
Arbor	Jefferson to Grace	.....	595	.....	.....	.....	.....	.....	.....
Audubon	Seventh to Drake	.....	745	.....	.....	.....	.....	.....	.....
Ada	Roble to Congress	334	332.5	.....	.....	.....	.....	.....	.....
Anita	Concord 25 feet east	25	.....	.....	.....	.....	.....	.....	.....
Banfil	Smith to Duke	2302	667	.....	.....	.....	.....	.....	.....
Bay	Stewart to Randolph	.....	1944	.....	.....	.....	.....	.....	.....
Becker pl	Lafayette to De Soto	.....	481	.....	.....	.....	.....	.....	.....
Belvidere	Andrew to Concord	.....	1647	.....	.....	.....	.....	.....	.....
Bradley	100 feet south of Grove to North	.....	1503	.....	.....	.....	.....	.....	.....
Bellows	Winifred 25 ft. north	.....	25	.....	.....	.....	.....	.....	.....
*Broadway	Mississippi river to University av	498	1735	.....	.....	1938	.....	1741	.....
Bruno	East of Lafayette	.....	47	.....	.....	.....	.....	.....	.....
Bancroft	Concord to Congress	.....	935	.....	.....	.....	.....	.....	.....
Bidwell	Isabel to Congress	.....	302	.....	.....	.....	.....	.....	.....
Brunson	Partridge to North	.....	788	.....	.....	.....	.....	.....	.....
Canada	Ninth to University	.....	2055	.....	.....	.....	.....	.....	.....
Cedar	Summit to Second	.....	289	176	2573	.....	614	.....	.....
Chestnut	Seventh to Washington	.....	1235	.....	.....	.....	.....	.....	.....
Colborne	Jefferson to Superior	.....	1763	.....	.....	.....	.....	.....	.....
College	Cedar to Smith	.....	1670	.....	.....	.....	.....	.....	.....
Cross Miss. river	Broadway to State	.....	.....	.....	.....	1089	.....	.....	.....
Concord	Isabel to Belvidere	.....	.....	.....	6860	.....	.....	.....	.....
Congress	350 feet east of Bancroft to Charlton	392	6425	.....	.....	.....	.....	.....	.....
Chicago	Wabasha to S. Robert	.....	741	.....	.....	.....	.....	.....	.....
Colorado	R. R. to Stryker	.....	1624	.....	.....	.....	.....	.....	.....
Clinton	Congress to Winifred	.....	403	.....	.....	.....	.....	.....	.....
Columbia	Glencoe to Pennsylvania	.....	745	.....	.....	.....	.....	.....	.....
Cliff	Goodhue to Smith	.....	250.5	.....	.....	.....	.....	.....	.....
De Soto	Hopkins to Becker pl	.....	180	.....	1540	.....	.....	.....	.....
Douglas	Seventh to Ramsey	.....	1144	.....	.....	.....	.....	.....	.....
Duke	Cascade to St. Clair	.....	1893	.....	.....	.....	.....	.....	.....
Dousman	Von Minden to Goodhue	.....	576	.....	.....	.....	.....	.....	.....
Delos	Greenwood to Bellows	.....	2934	.....	.....	.....	.....	.....	.....
Daly	James to Jefferson	.....	1050	.....	.....	.....	.....	.....	.....
Dearborn	Robert to Gorman	.....	705	.....	.....	.....	.....	.....	.....
Eagle	Spring to Seventh	.....	1449	.....	.....	.....	.....	.....	.....
Eighth	Wabasha—110 ft. east of Neill	1425	.....	3321	.....	.....	.....	.....	.....
Eleventh	Cedar to Jackson	.....	1238	.....	.....	.....	.....	.....	.....
Elm	Exchange to C., M. & St. P. R. R.	406	.....	.....	.....	.....	.....	.....	.....
Exchange	Wabasha to Wilkin	3962	323	.....	.....	.....	.....	.....	.....
Eaton	At Indiana and Fairfield crossings	.....	51	.....	.....	100	.....	.....	.....
Erie	St. Clair to Cascade	.....	1807	.....	.....	.....	.....	.....	.....
Emma	Western to Short Line	373	.....	.....	.....	.....	.....	.....	.....
Fairfield	State to Wabasha	.....	2812	.....	.....	.....	.....	.....	.....
Fauquier	Payne to De Soto	.....	.....	.....	1982	.....	.....	.....	.....
Fifth	Third to Kittson	1458	3120	.....	2938	.....	.....	.....	.....
Fort	Seventh to Tenth	.....	.....	.....	.....	.....	1616	.....	.....
Fourth	Exchange to 762 feet east of Kittson	.....	4865	.....	2679	.....	.....	.....	.....
Fourteenth	Broadway to Robert	.....	1368	.....	.....	.....	.....	.....	.....
Franklin	Elm to Ninth	3308	.....	.....	.....	.....	.....	.....	.....
Fillmore	Wabasha to State	.....	2808	.....	.....	.....	.....	.....	.....
Forbes	Wilkin to Douglas	.....	1274	.....	.....	.....	.....	.....	.....
Garfield	Ramsey to Goodrich	.....	1002	.....	.....	.....	.....	.....	.....
Goodhue	Cliff to Duke	.....	2817	.....	.....	.....	.....	.....	.....

*Includes portion of Mississippi street south of Grove street.

WATER MAINS ON LOW SERVICE—*Continued.*

STREET.	From Street to Street.	4-Inch.	6-Inch.	8-Inch.	12-Inch.	16-Inch.	20-Inch.	24-Inch.	30-Inch.
Goodrich	Milwaukee Short Line to Pleasant	.....	1331	.....	2328	.....	.....	.....	.....
Grace	Seventh to Colborne	.....	72	.....	.....	.....	.....	.....	.....
Grove	Monroe to Jackson	133	1310	.....	.....	.....	1544	.....	.....
Glencoe	Mississippi to Columbia	.....	592	.....	.....	.....	.....	.....	.....
George	State to Stryker	.....	.....	.....	2625	.....	.....	.....	.....
Goff	Wabasha to Winifred	.....	105	.....	.....	.....	.....	.....	.....
Greenwood	Winifred to Delos	310	305	.....	.....	.....	.....	.....	.....
Harrison av.	Douglas to Goodrich	.....	2381	.....	.....	.....	.....	.....	.....
Hopkins	De Soto to Bradley	.....	700	.....	.....	.....	.....	.....	.....
Hall	George to Prospect ter	.....	2080	.....	.....	.....	.....	.....	.....
Indiana	State to Ethel	.....	.....	.....	2462	2242	.....	.....	.....
Isabel	State to Charlton	.....	.....	.....	5055	.....	.....	.....	.....
Jackson	Levee to University	40	1223	.....	3179	.....	108	.....	.....
Jefferson	Erie to Arbor	.....	63	.....	1171	.....	.....	.....	.....
James	Webster to Victoria	.....	2338.5	.....	.....	.....	.....	.....	.....
John	Third to Williams	889	2449	.....	.....	.....	.....	.....	.....
Juno	View to Chatsworth	.....	2130	.....	.....	.....	.....	.....	.....
Kittson	Fourth to Seventh	.....	846	.....	.....	.....	.....	.....	.....
Kittson's ad.	Alley, block 4	.....	.....	.....	222	.....	.....	.....	.....
Kentucky	Crossing State	.....	55	.....	.....	.....	.....	.....	.....
Lafayette	Grove to De Soto	.....	.....	.....	150	1915	.....	.....	.....
Lee	Seventh to Drake	.....	1445	.....	.....	.....	.....	.....	.....
Leech	Goodrich to Ramsey	.....	1146	.....	.....	.....	.....	.....	.....
Levee	Olive to Jackson	340	614	.....	.....	.....	.....	.....	.....
L'Orient	Thirteenth to Minnehaha	.....	2209	.....	.....	.....	.....	.....	.....
Livingston	Delos to Wood	.....	580	.....	.....	.....	.....	.....	.....
Lisbon	Douglas to Pleasant	.....	973	.....	.....	.....	.....	.....	.....
Logan	Bay to Canton	.....	814	.....	.....	.....	.....	.....	.....
Louisa	Robert to Gorman	.....	701	.....	.....	.....	.....	.....	.....
Locust	.....	.....	.....	.....	.....	627	288	.....	.....
McBoal	Wilkin to Douglas	.....	1301	.....	.....	.....	.....	.....	.....
Magnolia	Crossing Mississippi	.....	18	.....	.....	.....	.....	.....	.....
Market	Third to Fourth	250	.....	.....	.....	.....	.....	.....	.....
Minnesota	Third to Twelfth	1484	1428	.....	.....	.....	.....	.....	.....
Mississippi	Grove to Overton	.....	5165	.....	.....	.....	.....	8013	.....
Monroe pl	Grove to Woodward	300	.....	.....	.....	.....	.....	.....	.....
Mt. Airy	Mississippi to L'Orient	.....	330	.....	.....	.....	.....	.....	.....
Michigan	W.Seventh to Richmond	.....	629	.....	.....	.....	.....	.....	.....
Mayall Alley	Seventh to Ninth	410	.....	.....	.....	.....	.....	.....	.....
Midway	Oakdale to Brown	.....	1847	.....	.....	.....	.....	.....	.....
Nash	Pine to L'Orient	.....	698	.....	.....	.....	.....	.....	.....
Neill	Seventh to Eighth	325	.....	.....	.....	.....	.....	.....	.....
Ninth	Neill to Smith	975	5187	.....	.....	.....	.....	.....	.....
Norris	Canada to Temperance	761	.....	.....	.....	.....	.....	.....	.....
Nugent	St. Clair to C., M. & St. P. Short Line	.....	513	.....	.....	.....	.....	.....	.....
Olive	Sixth to Olmsted	236	1248	.....	.....	.....	.....	.....	.....
Olmsted	John to Pine	.....	651	.....	.....	.....	.....	.....	.....
Oneida	Grace to 36 feet south of Seventh	.....	634	.....	.....	.....	.....	.....	.....
Ontario	Washington to Spring	112	.....	.....	.....	.....	.....	.....	.....
Oakdale	State to Midway	.....	326	.....	.....	350	.....	.....	.....
Overton av	Mississippi to terminal chamber	.....	.....	.....	.....	.....	.....	.....	*8423
Page	Concord to Andrew	.....	1030.5	.....	.....	.....	.....	.....	.....
Partridge	Bradley to De Soto	472	.....	.....	.....	.....	.....	.....	.....
Pine	Seventh to Olmsted	977	1263	.....	132	.....	.....	.....	.....
Plato	West of South Robert	.....	18	.....	.....	.....	.....	.....	.....
Pleasant	Sixth to Goodrich	.....	4884	.....	.....	.....	.....	.....	.....
Prince	John to Broadway	.....	825	.....	.....	.....	.....	.....	.....
Pennsylvania	Mississippi to a point 300 feet west of Columbia	.....	961	.....	.....	.....	.....	.....	.....
Prescott	Oakdale to Woodbury	.....	1365	.....	.....	.....	.....	.....	.....
Ramsey	Seventh to Pleasant	.....	1352	.....	.....	307	.....	.....	.....
Randolph	Webster to Milton	.....	757	.....	2818	.....	.....	.....	.....
Richmond	Grace and Goodrich	.....	284	.....	.....	.....	.....	.....	.....
Robert	Elizabeth to Central	.....	8881	.....	.....	.....	.....	.....	.....
Rosabel	Union depot grounds to Seventh	.....	1508	.....	.....	.....	.....	.....	.....
Robie	Winslow to Andrew	.....	2669	.....	.....	.....	.....	.....	.....
St. Clair	Cliff to Colborne	.....	985	.....	351	.....	.....	.....	.....
St. Peter	Third to College	.....	2866	.....	.....	.....	.....	.....	.....

*Also 18 feet 36-inch, Overton avenue, Mississippi to terminal chamber.

WATER MAINS ON LOW SERVICE—*Continued.*

STREET.	From Street to Street.	4-Inch.	6-Inch.	8-Inch.	12-Inch.	16-Inch.	20-Inch.	24 Inch	30-Inch.
Seventh.....	Duluth R. R. to Tuscarora	350	1000	.....	470	15656	1508		
Second.....	East of Robert.....	.....	18	.....	.....	.....	.....	.....	.....
Sherman.....	Bluff to Pleasant.....	.....	1937	.....	.....	.....	.....	.....	.....
Sixth.....	Kittson to Pleasant....	1896	2044	3235	.....	.....	.....	.....	.....
Sibley.....	Levee to Norris.....	1626	1462	.....	.....	.....	.....	.....	.....
Smith.....	College to Cliff.....	.....	3764	.....	.....	.....	.....	.....	.....
Somerset.....	John to Pine.....	.....	669	.....	.....	.....	.....	.....	.....
Spruce.....	Sibley to Pine.....	442	241	.....	.....	.....	.....	.....	....
State.....	Mississippi river to West Side pumphouse	.....	.....	.....	.....	7704	.....	.....	.....
Superior.....	Western to Duke.....	.....	1282.5	.....	.....	.....	.....	.....	.....
Summit.....	Robert to Cedar.....	.....	859	.....	.....	.....	.....	.....	.....
Sturgis.....	Douglas to Garfield....	.....	660	.....	.....	.....	.....	.....	.....
Stryker.....	George to Prospect ter.	.....	2106	.....	.....	.....	.....	.....	.....
Stewart.....	Tuscarora to Otto.....	.....	1736.5	.....	.....	.....	.....	.....	.....
Temperance...	Eighth to Thirteenth...	1569	.....	.....	.....	.....	.....	.....	.....
Tenth.....	Grove to College.....	441	1531	.....	2289	139	1390	.....	.....
Third.....	Pleasant to west end of Third street bridge...	.....	847	.....	6648	.....	.....	.....	.....
Thirteenth....	Fine to Jackson.....	.....	2075	.....	.....	.....	.....	.....	.....
Thompson....	Ramsey to Pleasant....	.....	545	.....	.....	.....	.....	.....	.....
Twelfth.....	Jackson to Cedar.....	.....	.....	.....	.....	.....	1274	.....	.....
Toronto.....	Seventh to Jefferson...	.....	692	.....	.....	.....	.....	.....	.....
Tennessee.....	Crossing State	.....	51	.....	.....	.....	.....	.....	.....
Tuscarora.....	Stewart to Chatsworth..	.....	3285	.....	.....	.....	.....	.....	.....
Van Slyke court.....	Broadway to Olive....	557	.....	.....	.....	.....	.....	.....	...
Von Minden..	Dousman to Western..	.....	897	.....	.....	.....	.....	.....	.....
View.....	Seventh to Palace.....	.....	2081	.....	.....	.....	.....	.....	.....
Wacouta.....	Union Depot ground to Spruce	783	118	.....	1736	.....	.....	.....	.....
Walnut.....	100 feet south of I. P. to Pleasant	2420	.....	.....	.....	.....	.....	.....	.....
Warsaw.....	Audubon to Jefferson..	.....	1613	.....	.....	.....	.....	.....	.....
Washington...	Chestnut to Seventh....	1047	.....	.....	1236	.....	.....	.....	.....
Waverly pl...	Lafayette to John.....	.....	411	.....	.....	.....	.....	.....	.....
Webster.....	Clay to Seventh.....	.....	316	.....	.....	.....	.....	.....	.....
Western.....	Milwaukee Ry. to Pleasant	.....	2550	.....	.....	.....	.....	.....	.....
Westminster..	Waverly pl. to N. P. Ry	.....	1022	.....	.....	.....	.....	.....	.....
Willius.....	Fifth to Seventh.....	550	.....	.....	.....	.....	.....	.....	.....
Wilkin.....	Short Line Ry. to Pleasant	.....	1209	.....	.....	.....	.....	.....	.....
Winifred.....	Charlton to Andrew....	.....	6097	.....	.....	.....	.....	.....	.....
Whitney & Smith's ad..	Alley, block 15.....	.....	355.5	.....	.....	.....	.....	.....	.....
Woodward....	Bradley to John.....	683	.....	.....	.....	.....	.....	.....	.....
Wabasha.....	Goff to Summit.....	.....	6074	.....	.....	2553	.....	.....	.....
Watson.....	View to Chatsworth...	.....	2133	.....	.....	.....	.....	.....	.....
Winslow.....	Isabel to Prospect ter..	.....	745	.....	.....	.....	.....	.....	.....
Yankee.....	Seventh to Dousman...	678	.....	.....	.....	.....	.....	.....	.....
Main old line.	Fauquier to Lake Phalen	.....	.....	.....	.....	6000	.....	7024	.....
	Totals	35539	192,186.5	6732	51444	40620	8342	8765	16436

		Feet.
Total 4-inch	pipe.....	35,539
Total 6-inch	pipe.....	194,885.5
Total 8-inch	pipe.....	6,732
Total 12-inch	pipe.....	51,444
Total 16-inch	pipe.....	40,620
Total 20-inch	pipe.....	8,342
Total 24-inch	pipe.....	8,765
Total 30-inch	pipe.....	16,436
Total 36-inch	pipe.....	18
Total		362,781.5 feet, or 68.7086 miles.

There are 16,177 feet of tunnels for mains and 900 feet of tunnels for fire hydrants in the sand-rock district. Size of same, 6 feetin height and 3.5 feet in width, tapering towards top to 1.5 feet.

There are also 12 ventilating and riser shafts, and 49 hydrant shafts 7 feet in diameter *at bottom and* tapering towards top to about 2 feet. They are bricked from top of solid *rock to a height of* about 10 feet.

TABLE NO. 12.

LOCATION, SIZE AND NUMBER OF FEET OF WATER MAINS LAID ON HIGH SERVICE, WEST SIDE, TO JAN. 1, 1902.

STREET.	From Street to Street.	6 Inch.	12 Inch.	16 Inch.
Annapolis.....	At Manomin	.....	100	.....
Alice.....	Ohio to the Park.....	141	.....	.....
Baker.....	Bidwell to Delaware.....	.....	3,850	.....
Belvidere.....	South Robert to Oakdale.....	851	.....	.....
Bidwell.....	Morton to Robie.....	.....	346	362
Bunker.....	Oakdale to Brown.....	1,808	.....	.....
Cherokee ave.	Annapolis to N. L. of Smith avenue.....	4,349	.....	.....
Force main...	From Annapolis to Tank.....	.....	100	.....
Curtice.....	Oakdale to 250 feet east of Woodbury.....	1,437	.....	.....
Delaware.....	Baker to Annapolis.....	2,552.5	.....	.....
George.....	Stryker to Smith avenue.....	3,581	.....	.....
Hall avenue..	Morton to Louisa.....	894	.....	.....
King.....	Ohio to Orleans.....	587	.....	.....
Manomin.....	Baker to Annapolis.....	.....	2,540	.....
Morton.....	Robert to Bidwell.....	.....	.....	2,672
Oakdale ave..	Midway to Curtice.....	1,319	.....	.....
Orleans.....	Cherokee to Page.....	2,517	.....	.....
Ohio.....	Winona to Cherokee.....	3,900	.....	.....
Page.....	Robert to Harvard.....	1,344	.....	170
Robert.....	Belvidere to Morton.....	.....	594	606
Robie.....	Bidwell to Orleans.....	1,109	.....	.....
State.....	Page to Pump House.....	.....	.....	140
Sidney.....	Ottawa to Cherokee.....	346	.....	.....
Smith avenue.	Morton to George.....	1,444	.....	.....
Stryker ave..	Tyler to George.....	1,388	.....	.....
	Totals	27,643.5	7,530	3,950

	Feet
Total 6-inch pipe.....	29,567.5
Total 12-inch pipe.....	7,530
Total 16-inch pipe.....	3,950
Total	41,047.5 feet or 7.7741 miles.

TABLE NO. 13.

INVENTORY OF STOCK JAN. 1, 1902.

PIPES AND SPECIALS.

195 feet 36-inch pipe (cast iron).
35 feet 30-inch pipe (cast iron).
281 feet 24-inch pipe (cast iron).
18 feet 24-inch pipe (cast iron) light.
171 feet 20-inch pipe (cast iron).
1,077½ feet 16-inch pipe (cast iron).
12 feet 14-inch pipe (cast iron).
808 feet 12-inch pipe (cast iron).
75 feet 12-inch pipe (flange).
44 feet 10-inch pipe (cast iron).
407 feet 8-inch pipe (cast iron).
566 feet 6-inch pipe (cast iron).
210 feet 4-inch pipe (cast iron).
2 feet 3-inch pipe (cast iron).
3 feet 8-inch pipe (wrought iron).
6 feet 6-inch pipe (wrought iron).
27 feet 4-inch pipe (wrought iron).
9½ feet 3-inch pipe (galvanized).
18 feet 2½-inch pipe (galvanized).
37 feet 2-inch pipe (galvanized).
500 feet 2-inch (galvanized, old).
10 feet 1¼-inch (galvanized).
32 feet 1-inch (galvanized).
65 feet ¾-inch (galvanized), old.
300 feet 1½-inch pipe (galvanized).
1 30-inch 1-16-bend.
3 24-inch 1-16-bend.
1 20-inch ¼-bend.
1 20-inch ⅛-bend.
2 24-inch ⅛-bend.
3 16-inch ⅛-bend.
2 16-inch ¼-bend.
2 8-inch ¼-bend.
2 8-inch ⅛-bend.
4 6-inch ¼-bend.
2 4-inch ¼-bend.
1 4-inch ⅛-bend.
3 36-inch sleeves.
1 24-inch sleeve.
3 20-inch sleeves.
3 16-inch sleeves.
2 12-inch sleeves.
6 8-inch sleeves.
7 6-inch sleeves.
6 4-inch sleeves.
1 30-inch sleeve, open.
1 24-inch sleeve, open.
3 16-inch sleeves, open.
2 12-inch sleeves, open.
1 8-inch sleeve, open.
4 6-inch sleeves, open.
5 6x6-inch sleeves, open.
5 4-inch sleeves, open.
1 4-inch sleeve, open (2 holes.)
1 16x6-inch sleeve and gate, Smith patent.
1 16x4-inch sleeve and gate, Smith patent.
2 12x6-inch sleeves and gates, Smith patent.
4 12x4-inch sleeves and gates, Smith patent.
3 8x6-inch sleeves and gates, Smith patent.
2 8x4-inch sleeves and gates, Smith patent.
3 6x6-inch sleeves and gates, Smith patent.
7 6x4-inch sleeves and gates, Smith patent.
1 6x3-inch sleeve and gate, Smith patent.
3 6x2-inch sleeves and gates, Smith patent.
2 36-inch plugs.
1 30-inch plug.
4 24-inch plugs.
5 20-inch plugs.
3 16-inch plugs.
2 12-inch plugs.
4 8-inch plugs.
41 6-inch plugs.
32 4-inch plugs.
22 4-inch plugs, with 2-inch holes.
1 30x6-inch 4-way.
1 24x24x16-inch 3-way branch.
1 24x12-inch 4-way branch.
1 24x 6-inch 4-way branch.
1 24x 4-inch 4-way branch.
1 20x 6-inch 3-way branch.
1 16x 6-inch 4-way branch.
1 16x 4-inch 3-way branch.
1 16x12-inch 4-way branch.
1 12x12-inch 4-way branch.
1 12x12-inch 3-way branch.
1 12x 6-inch 3-way branch.
4 12x 4-inch 3-way branches.
2 8x 6-inch 4-way branches.
1 8x8x6-inch 3-way branch.
3 6x6-inch 4-way branches.
7 6x6-ineh 3-way branches.
15 6x4-inch 4-way branches.
8 6x4-inch 3-way branches.
13 4x4-inch 4-way branches.
24 4x4-inch 3-way branches.
2 4x3-inch 3-way branches.
1 36x36x24-inch "Y."
1 20x20x20-inch "Y."
1 24x20x20-inch "Y."
1 12x12x12-inch "Y."
1 24x16-inch reducer.
1 20x12-inch reducer.
2 16x12-inch reducers.
7 12x 6-inch reducers.
1 8x 6-inch reducer.
2 6x 4-inch reducers.

REPORT OF CHIEF ENGINEER.

ST. PAUL WATER WORKS PUMPING STATION,
McCARRON LAKE, Dec. 31, 1901.

To the Board of Water Commissioners,

GENTLEMEN: I herewith submit the seventeenth annual report of the five pumping stations.

McCARRON LAKE STATION.

Total gallons pumped	1,426,620,000
Daily average gallons pumped	3,908,542
Total pounds of coal used	2,124,125
Daily average coal used	5,819
Daily decrease since 1900 (gallons)	56,135

WEST SIDE PUMPING STATION.

Total number of gallons pumped	17,682,660
Daily average gallons pumped	48,445
Total pounds of coal used	240,800
Daily average coal used	659
Daily increase since 1900 (gallons)	4,397

CENTERVILLE LAKE STATION.

Total number of gallons pumped	1,462,345,200
Daily average gallons pumped	15,142,410
Total cords wood used (softwood)	328
Daily average cordwood used	3.4
Daily average pounds coal used	660

VADNAIS LAKE PUMPING STATION.

Total gallons pumped	893,940,400
Daily average gallons pumped	5,100,470
Total pounds of coal used	263,300
Daily average coal used	2,780

Baldwin Lake station has not been in operation during the year 1901.

Respectfully submitted,

MARTIN FEIST,
Chief Engineer.

ST. PAUL WATER WORKS PUMPING STATION, CENTERVILLE LAKE.

ENGINEER'S REPORT FOR THE YEAR ENDING DEC. 31, 1901.

MONTHS—1901.	Number of Hours Pumped	Total Number of Gallons Pumped.	Daily Average Gallons Pumped.	Total Pounds of Coal Used.	Total Cord Wood Used.
August	526	333,727,800	15,169,445	11,250	74½
September	698	440,264,400	15,181,531	26,700	93
October	742	470,020,800	15,161,303	18,500	106
November	349	218,332,200	15,056,702	7,300	54½
Total	2,315	1,462,345,200	15,142,410	63,750	328

Total gallons pumped	1,462,345,200
Daily average gallons pumped	15,142,410
Total cords soft wood used	328
Daily average cords wood used	3.41
Daily average pounds coal used	660

ST. PAUL WATER WORKS PUMPING STATION, VADNAIS LAKE.

ENGINEER'S REPORT FOR THE YEAR ENDING DEC. 31, 1901.

MONTHS—1901.	Number of Hours Pumped.	Total Number of Gallons Pumped.	Daily Average Gallons Pumped.	Total Pounds of Coal Used.	Daily Average Coal Used.
July	216	46,481,600	5,164,622	24,300	2,700
August	689	146,210,800	5,041,750	76,600	2,641
September	671	143,695,200	5,131,971	78,000	2,785
October	505	106,585,600	5,075,504	65,400	2,850
November	147	30,967,200	5,068,504	19,000	2,928
Total	2,228	493,940,400	5,100,470	263,300	2,780

Total gallons pumped	893,940,400
Daily average gallons pumped	5,100,470
Total pounds of coal used	263,300
Daily average of coal used	2,780

ST. PAUL WATER WORKS PUMPING STATION, WEST SIDE.

ENGINEER'S REPORT FOR THE YEAR ENDING DEC. 31, 1901.

MONTHS—1901.	Number of Hours Pumped.	Total Number of Gallons Pumped.	Daily Average Gallons Pumped.	Total Pounds of Coal Used.	Daily Average Coal Used.
January	12.35	569,520	18,371	16,500	535
February	12.35	559,800	19,992	15,800	565
March	11.35	527,400	17,012	14,800	477
April	105.	3,822,480	127,416	31,900	*1,063
May	36.35	1,491,480	48,112	19,200	619
June	38.45	1,596,600	53,220	20,000	666
July	53.25	2,206,620	71,181	23,300	751
August	58.25	2,438,280	78,654	24,600	793
September	44.5	1,826,820	60,994	21,700	723
October	30.7	1,076,760	34,734	17,200	554
November	17.55	756,000	25,200	16,700	556
December	19.40	810,900	26,158	19,100	616
Total	435.21	17,682,660	48,445	240,800	659

*Repairing and cleaning tank.

Total gallons pumped	17,682,660
Daily average gallons pumped	48,445
Total pounds of coal used	240,800
Daily average coal used, pounds	659
Daily increase since 1900	4,379

NUMBER OF CUBIC FEET OF VENTURI METER OF LOW SERVICE FROM VADNAIS LAKE FOR THE YEAR ENDING DEC. 31, 1901.

MONTHS—1901.	Number of Cubic Feet.	Number of Gallons.	Daily Average Gallons.
January	14,392,000	107,652,160	3,472,650
February	12,279,000	91,846,920	3,280,247
March	13,309,000	99,551,320	3,211,333
April	14,080,000	105,318,400	3,510,613
May	15,198,000	113,681,040	3,667,130
June	15,095,000	112,910,600	3,763,686
July	17,614,000	131,752,720	4,250,087
August	18,743,600	140,197,640	4,522,504
September	17,899,600	133,869,560	4,462,484
October	16,811,000	125,746,280	4,056,331
November	14,035,000	104,981,000	3,499,366
December	19,528,000	146,069,440	4,711,917
Total	188,524,440	1,410,162,811	3,863,459

Daily increase since 1900, 231,594 gallons.

ST. PAUL WATER WORKS PUMPING STATION, McCARRON LAKE.

ENGINEER'S REPORT FOR THE YEAR ENDING DEC. 31, 1901.

Months—1901.	Number of Hours Pumped.			Number of Gallons Pumped.			Total Gallons Pumped.	Average Gallons Pumped Per Day.	Total Pounds of Coal Used Per Month	Average Coal Used Per Day.
	Engine No. 1.	Eng. No. 2.	Engine No. 3.	Engine No. 1.	Engine No. 2.	Engine No. 3.				
January	164	27	434	39,614,400	3,876,000	58,286,800	101,777,200	3,283,135	180,201	5,835
February	.....	.....	670	.....	.....	95,881,500	95,881,500	3,424,339	165,916	5,925
March	.....	.....	733	.....	.....	100,357,400	100,357,400	3,237,335	167,824	5,413
April	.....	.....	711	.....	.....	101,129,600	101,129,600	3,370,986	149,474	4,982
May	.....	.....	740	.....	.....	138,037,900	138,037,900	4,452,835	189,414	6,110
June	.....	.....	714	.....	.....	127,312,900	127,312,900	4,243,763	177,884	5,929
July	243	27	643	66,731,400	3,406,800	91,577,200	161,715,400	5,216,625	205,313	6,623
August	194	.....	522	49,753,800	.....	108,765,700	158,519,500	5,113,532	205,503	6,629
September	14	.....	690	4,061,000	.....	119,834,000	123,895,000	4,129,833	174,734	5,826
October	.....	.....	695	.....	.....	99,799,700	99,799,700	3,212,893	155,880	5,028
November	.....	.....	720	.....	.....	100,557,800	100,557,800	3,358,593	165,596	5,514
December	.....	.....	744	.....	.....	107,636,100	107,636,100	3,472,132	186,386	6,012
Total	615	54	7,516	160,160,600	7,282,800	1,259,176,700	1,426,620,000	3,908,542	2,124,125	5,819

Total gallons pumped..... 1,426,620,000
Daily average gallons pumped..... 3,908,542
Total pounds of coal used..... 2,124,125
Daily average coal used..... 5,819
Daily decrease since 1900, gallons..... 56,135

NOTE.—Coal for heating buildings, changing boilers and electric light plant is included in above statement.

MARTIN FEIST, Chief Engineer.

ENGINEER'S REPORT.

ST. PAUL, MINN., Jan. 1, 1902.

WATER WORKS.

In the following a report is submitted of work done under charge of the engineering department during the year 1901, with tables and tabulation relative to the water supply and water consumption and the cost of pumping at the various stations.

SURVEYS AND MAPS.

Considerable field work was done in determining the amount of land required to be condemned for flowage rights and maps executed therefor.

ELECTROLYSIS.

The most important work during the season executed by the engineering department for the Board of Water Commissioners was the investigation of electrolysis. A very exhaustive examination was made, covering the entire city. The findings of this report and a map showing the data of the electrical survey will be included in the annual report of the Board of Water Commissioners. A formal notice was served upon the Street Railway Company by the Board of Water Commissioners, directing that the Street Railway Company take the proper steps looking to the adoption of some new system or to so change the existing one as to prevent any further damage to the water supply system of the city of St. Paul, and that legal proceedings against the Street Railway Company would be commenced unless the system was changed within a reasonable time, and further that the Street Railway Company would be held liable for any and all damages sustained to the water system of the city of St. Paul.

WATER CONSUMPTION.

The usual record has been kept of the water consumption during the year on each system, the results of which are shown in table 35. The total amount of water used was 2,929,658,966 gallons, being an average of 8,026,435 gallons per day.

UNITED STATES WEATHER BUREAU DATA.

Tables 36, 37 and 38 furnish data as to cloudiness, precipitation and annual rainfall, the information being obtained from the United States Weather Bureau at St. Paul. The total amount of precipitation for year was 25.75, which is about one and three-fourths inches less than the average record of yearly rainfall from 1837 to the present time.

COST OF PUMPING.

The following tabulation shows the cost of the pumping at the various pumping stations, to-wit:

COST OF PUMPING WATER AT THE VARIOUS PUMPING STATIONS.

McCARRON PUMPING STATION.

	Gallons Pumped in 1901.	Pounds of Coal Consumed.	No. of Gallons per Pound of Coal.
Ten-million gallon engine	160,049,600	194,261	823.9
Six-million gallon engine	1,248,786,100	1,903,161	656.1
Four-million gallon engine	7,282,800	14,817	491.5
Totals, three engines	1,416,118,500	2,112,239	
Average of three engines, gallons per pound of coal			670.5

	Foot Pounds.
Average duty during the year for ten-million engine	93,336,000
Average duty during the year for six-million engine	74,335,000
Average duty during the year for four-million engine	55,682,000
Average duty during the year for the whole plant	75,952,000

		Cost of Raising 1,000,000 Gals. One Foot.
Salaries for 1901	$5,760.00	$0.029909
Fuel	4,455.52	0.023132
Waste, oil, repairs, etc	529.72	0.002750
Totals	$10,745.24	$0.055790

WEST ST. PAUL PUMPING STATION.

Amount of water pumped during 1901, gallons	17,687,340
Average rate of pumping in twenty-four hours, gallons	48,457
Amount of fuel consumed, pounds	240,800
Average duty during the year, foot-pounds	12,372,000

		Cost of Raising 1,000,000 Gals. One Foot.
Salaries for 1901	$1,380.00	$0.37330
Fuel	537.57	0.14542
Waste, oil, repairs	98.78	0.02670
Totals	$2,016.35	$0.54546

VADNAIS LAKE PUMPING STATION.

Amount of water pumped during 1901, gallons	427,224,400
Amount of fuel consumed, pounds	268,300
Average duty during the year, foot-pounds	56,607,000

		Cost of Raising 1,000,000 Gals. One Foot.
Salaries for 1901	$818.00	$0.049077
Fuel	641.48	0.030850
Waste, oil and repairs	76.81	0.004610
Totals	$1,536.29	$0.092204

CENTERVILLE PUMPING STATION.

Amount of water pumped during 1901, gallons	1,461,249,200

		Cost of Raising 1,000,000 Gals. One Foot.
Salaries for 1901	$1,002.50	$0.01460
Fuel	758.74	0.01104
Waste, oil and repairs	90.80	0.00132
Totals	$1,852.04	$0.02690

McCARRON LAKE PUMPING STATION.

ECONOMIC EVAPORATION.

Feed water evaporated, cubic feet	253,208
Average temperature of feed	113°
Weight of one cubic foot, pounds	61.85
Total weight of feed water, pounds	15,660,914
Average steam pressure, pounds	94
Coal consumed, pounds	2,112,239
Total combustible, pounds	1,914,784

$$\text{Actual Evaporation per pound of coal} = \frac{15,660,914}{2,112,239} = 7.41 \text{ lbs.}$$

$$\text{Equivalent evaporation from and at 212° per pound of coal} = \frac{15,660,914 \times 1.1418}{2,112,239} = 8,418 \text{ lbs.}$$

$$\text{Equivalent evaporation from and at 212° per pound of combustible} = \frac{15,660,914 \times 1.1418}{1,914,784} = 9,338 \text{ lbs.}$$

TABLE NO. 35 A.

SHOWING WATER CONSUMED IN THE CITY OF ST. PAUL FOR THE YEAR 1901.

Month.	Sources of Supply.						Total Supply.	
	From Vadnais Lake.		From Artesian Wells.		From Lake Phalen.		Total Daily Average.	Total Supply.
	Total.	Daily Average.	Total.	Daily Average.	Total.	Daily Average.		
January	209,436,830	6,756,000	.....	.....	13,700,000	409,700	7,197,966	223,196,830
February	188,114,073	6,718,359	.....	.....	10,965,570	391,620	7,109,987	199,079,643
March	199,646,329	6,440,204	.....	.....	8,596,691	276,345	6,716,550	208,243,020
April	205,880,002	6,862,667	.....	.....	8,803,074	293,970	7,156,103	214,683,076
May	251,798,328	8,122,526	.....	.....	9,444,903	304,674	8,427,201	261,243,231
June	239,127,900	7,970,930	.....	.....	8,598,420	284,647	8,255,544	247,666,320
July	251,549,087	7,963,901	41,813,440	4,645,938	7,229,327	233,204	9,696,511	300,591,854
August	166,748,820	5,378,994	131,757,120	4,250,142	5,342,964	172,353	9,801,577	303,848,904
September	128,043,370	4,268,112	129,895,920	4,810,960	6,271,667	209,055	8,807,081	264,210,957
October	129,462,764	4,176,218	95,887,440	3,093,144	7,327,916	236,384	7,505,746	232,678,120
November	178,191,905	5,939,700	27,870,480	3,981,498	5,494,975	189,899	7,051,882	211,556,460
December	253,715,674	8,184,877	.....	.....	9,094,877	291,447	8,475,824	262,750,551
Totals	2,401,714,182	6,580,089	427,224,400	3,955,781	100,720,384	275,946	8,028,485	2,929,658,966

TABLE NO. 35.

SHOWING DISTRIBUTION OF TOTAL WATER SUPPLY FOR HIGH AND LOW SERVICE FOR THE YEAR 1901.

Month.	High Service.		Low Service (Which includes Phalen and West St. Paul).		West St. Paul High Service.		Total Consumption.
	Total for the Month.	Daily Average.	Total for the Month.	Daily Average.	Total for the Month.	Daily Average.	
January	101,777,200	3,283,139	120,790,110	3,900,035	569,520	18,371	223,136,830
February	96,253,300	3,437,618	102,266,543	3,652,376	559,800	19,992	199,079,643
March	100,357,400	3,237,335	107,328,220	3,462,200	527,400	17,012	208,213,020
April	100,629,100	3,354,303	110,231,496	3,674,383	3,822,480	127,416	214,683,076
May	138,109,400	4,455,142	121,642,351	3,923,946	1,491,480	48,112	261,243,231
June	126,740,900	4,224,696	119,328,640	3,977,621	1,596,780	53,226	247,666,320
July	161,601,000	5,212,935	136,789,514	4,412,371	2,207,340	71,205	300,591,854
August	158,308,500	5,106,726	143,101,944	4,616,159	2,438,460	78,660	303,848,904
September	124,088,000	4,134,600	138,342,537	4,611,418	1,830,420	61,014	264,210,957
October	99,595,200	3,212,748	132,006,160	4,258,263	1,076,760	34,734	232,678,120
November	101,072,400	3,369,080	109,728,060	3,657,602	756,000	25,200	211,556,460
December	107,633,100	3,472,132	154,303,551	4,977,534	810,900	26,158	262,750,551
Total	1,416,118,500	3,879,776	124,154,427	4,098,227	17,687,340	48,457	2,929,658,966

TABLE NO. 36.

CLOUDINESS, PRECIPITATION, ETC., ST. PAUL, MINN.

Month.	Number of Days.			Mean Cloudiness, on a Scale of "0" to "10," "0" Cloudless, "10" Entirely Cloudy.	Mean Relative Humidity.	No. of Days with 0.01 Inch or More of Precipitation.	Total Precipitation, Inches and Hundredths.	Mississippi River Stages of Water in Feet and Tenths.			
	Clear.	Partly Cloudy.	Cloudy.					Highest.	Date.	Lowest.	Date.
January	13	7	11	5.4	83	6	.37	.....	.....	.....	.....
February	13	11	4	3.8	82	4	.40	.....	11	.....	.....
March	7	9	15	6.5	81	14	2 52	5.8	26	5.2	29
Abril	9	13	8	5.5	61	5	1.14	7.5	12	5.4	1
May	13	10	8	4.5	60	7	1.64	7.3	9	5.1	31
*June	6	20	4	5.2	66	15	7.21	6.2	30	.4	18
July	10	19	2	4.5	65	8	2.30	7.2	11	3.9	30
August	16	12	3	3.9	74	8	2.08	3.8	1	2.3	13
September	10	9	11	5.5	72	14	5.04	2.7	3	2.0	22
October	15	9	7	4.4	69	9	.91	3.1	16	2.4	7
November	14	7	9	4.5	73	5	1.60	2.8	3	1.3	25
December	8	8	15	6.2	83	11	.54	.....	.....	.....	.....
Sums	134	134	97	59.9	874	106	25.75	.....	.. ..	.....	.....
Means	.....	.....	.....	5.0	72.8	.....	.....	.....	.....	.....	.....

*Remarks.—From Weather Bureau records.

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TABLE NO. 38.

RECORD OF THE MONTHLY AND ANNUAL RAINFALL (IN INCHES), FROM 1837 TO 1901, INCLUSIVE, ST. PAUL, MINN.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.
1837	.27	.35	.33	.95	2.65	3.46	2.78	1.32	5.10	3.15	1.37	2.34	24.02
1838	.65	.76	.15	2.41	3.05	4.76	11.11	3.08	.71	.16	.43	.45	27.72
1839	1.34	.36	.71	2.71	3.28	1.80	3.50	1.04	1.61	2.11	1.66	1.01	21.19
1840	.49	.49	.65	1.55	2.31	3.50	2.89	3.40	2.33	2.21	3.22	.13	23.17
1841	.24	.21	1.43	1.40	1.50	4.24	1.57	1.17	6.10	1.55	.84	1.42	21.67
1842	.95	.72	.44	2.17	1.68	3.73	1.78	4.81	4.83	2.11	3.46	.60	27.28
1843	1.15	1.46	.82	.75	3.12	5.22	2.09	1.84	5.14	.50	1.43	.27	23.79
1844	1.50	.72	.97	5.16	4.50	1.64	4.80	4.37	4.26	.97	.77	.58	30.24
1845	.49	1.40	2.80	3 15	1.51	6.80	2.56	3.28	2.21	.66	.40	.08	25.34
1846	.52	.03	1.71	2.90	2.00	3.10	4.95	3.80	2.33	2.45	2.10	.21	26.10
1847	.29	.11	.44	.45	4.96	2.66	3.66	2.49	4.00	.37	1.71	.66	21.80
1848	.62	1.13	1.71	.18	5.28	2.83	4.60	3.19	2.46	.68	.10	.40	23.18
1849	1.00	.61	4.11	5.62	6.57	3.14	7.59	9.60	2.75	5.35	1.40	1.95	49.69
1850	1.67	.83	2.23	2.60	.57	4.62	6.15	2.97	1.82	.32	1.68	.04	25.50
1851	.20	.13	1.23	2.68	3.96	2.15	2.60	3.29	3.64	1.18	2.31	.05	23.42
1852	1.09	.58	1.55	2.16	2.05	5.16	1.57	.89	2.51	4.10	1.92	2.27	25.85
1853	.....	.01	.02	.73	4.08	7.59	1.65	2.57	2.14	.01	.56	1.11	20.47
1854	.72	.03	1.03	2.51	4.30	3.31	3.92	1.75	6.55	1.23	.60	.64	26.59
1855	1.67	.41	1.84	.28	1.23	2.38	1.32	4.41	6.26	.90	2.38	1.67	24.75
1856	.89	.18	.22	4.47	1.62	.76	2.47	1.09	3.24	3.97	1.70	2.01	22.62
1857	3.48	.94	.79	4.25	2.05	6.74	.65	2.03	2.46	0.00	5.75	2.95	32.09
1858	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1859	.50	.50	3.33	1.70	4.95	5.49	2.95	2.72	3.95	.46	2.01	.75	29.31
1860	.14	1.15	1.04	2.92	6.85	5.00	1.76	.88	4.72	4.64	.52	.41	30.03
1861	.55	1.94	.15	2.50	6.36	4.86	2 69	2.97	2.67	2.80	2.54	.10	30.13
1862	1.35	.59	.95	2.67	1.35	2.66	10.15	4.58	2.89	1.06	.59	1.37	30.21
1863	1.12	.93	1.97	.80	2.87	.02	.63	3.19	1.23	1.44	.29	1.30	15.79
1864	.38	.....	1.28	.56	.47	1.62	4.00	2.00	1.14	1.60	1.09	.71	14.85
1865	.65	1.85	2.10	4.29	4.20	6.72	2.55	9.16	1.90	2.30	.23	2.19	38.14
1866	2.00	.30	1.32	2.26	.39	6.00	2.30	4.73	2.26	2.64	3.19	.50	27.89
1867	.97	1.12	1.00	2.93	4.45	9.55	2.83	2.32	5.71	1.01	.58	.66	33.13
1868	1.71	1.51	1.22	1.31	3.96	2.68	4.05	3.08	2.88	4.56	3.69	.58	31.23
1869	.42	2.83	.96	.56	2.34	2.22	1.67	7.62	10.61	.88	.75	.96	31.82
1870	1.34	.60	2.10	1.39	5.24	.79	3.13	8.56	3.28	1.95	1.40	.90	30.68
1871	1.61	.41	2.06	4.25	2.70	6.56	1.48	4.87	2.18	1.90	1.41	1.20	30.63
1872	.28	.26	1.64	1.69	5.71	3.81	4.23	3.52	5.62	.52	1.91	2.08	31 27
1873	1.31	1.54	1.34	2.44	4.63	7.74	3.83	4.61	2.56	2.57	.79	.38	33.74
1874	.49	1.07	2.24	.95	1.65	11.67	1.94	3.90	5.76	3.22	1.90	.72	35.51
1875	1.41	1.72	2.19	2.27	3.06	4.33	.82	8.74	2.16	1.56	.84	1.56	30.66
1876	.73	.66	1.43	2.23	3.15	2.02	2.73	5.28	2.99	1.27	.93	.25	23.67
1877	.55	.01	1.57	1.92	5.43	7.13	.52	2.83	2.56	3.62	1.24	1.42	28.80
1878	1.00	.67	1.24	2 43	2.33	3.58	4.47	1.43	2.13	1.85	.61	1.04	22.78
1879	.11	1.12	.97	.45	7.18	1.76	9.32	2.78	2.26	2.56	1.41	2.47	32.39
1880	.81	.97	2.30	1.58	2.63	5.55	2.75	3.63	1.74	2.18	2.93	2.69	29.76
1881	4.34	2.55	1.06	.47	4.34	2.87	2.60	4.55	9.95	4.44	1.36	.53	39.06
1882	.67	2.35	3.25	1.61	2.44	2.68	2.84	2.45	.27	1.99	1.61	.98	23.14
1883	.64	.44	.06	4.92	2.12	7.04	4.33	1.22	2.23	1.10	1.01	1.59	26.70
1884	.48	1.27	1.34	2.00	2.09	3.57	2.93	2.89	4.48	2.43	.65	1.98	26.11
1885	.30	.20	.55	3.19	2.12	3.73	5.86	3.69	3.52	.93	.60	.64	25.33
1886	1.76	.25	1.09	3.67	.82	3.63	1.44	2.27	3.69	.72	2.07	1.48	22.89
1887	1.79	.89	.33	3.14	1.60	2.89	3.89	3.37	4.35	1.48	.65	1.47	25.85
1888	.72	.64	1.11	5.14	4.75	1.95	5.55	2.23	1.70	1.10	.34	.63	25.86
1889	.55	.30	.99	1.14	2.86	1.61	3.08	3.56	.51	2.06	.97	1.32	16.96
1890	.95	.50	1.11	1.80	3.66	5.29	1.87	2.20	2.73	2.79	.38	.10	23.38
1891	1.01	1.18	.94	1.71	1.33	4.08	2.07	3.42	.58	1.57	1.03	2.87	21.79
1892	.20	1.44	.75	.97	5.17	7.50	9.04	3.66	1.72	1.39	.36	.53	32.73
1893	.73	1.87	1.96	5.30	2.66	2.00	1.68	2.40	2.70	1.49	.81	2.35	25.95
1894	1.04	.10	3.28	4.30	6.63	1.51	.13	.96	1.82	4.49	.61	1.53	25.80
1895	1.05	.42	.85	2.09	2.89	4.18	4.12	2.59	4.75	.09	.85	.38	24.26
1896	.81	.17	2.93	5.63	4.67	3.30	1.12	4.48	2.45	3.39	5.07	.71	34.73
1897	2.13	1.03	2.95	1.56	1.81	8.18	6.35	2.18	1.33	1.87	.93	.20	30.52
1898	.04	1.69	1.96	1.22	3.40	2.71	1.94	3.98	.90	5.81	1.59	.15	25.34
1899	.87	.95	2.87	1.35	3.50	7.23	1.51	2.80	1.21	3.09	.81	1.35	27.54
1900	.66	.73	1.48	1.80	.34	1.98	5.81	3.13	9.39	7.55	.88	.47	34.22
1901	.37	.40	2.52	1.14	1.64	7.21	2.30	2.08	5.04	.91	1.60	.54	25.75
Average	.933	.821	1.450	2.301	3.202	4.163	3.366	3.363	3.290	2.019	1.570	1.046	27.524

Average annual rainfall from 1837 to 1901, inclusive, 27.524 inches.

Respectfully submitted,

O. CLAUSSEN,

Commr. of Pub. Works.

REPORT OF INSPECTOR OF METERS.

ST. PAUL, Jan. 2, 1902.

John Caulfield, Secretary Board Water Commissioners,

DEAR SIR: I herewith submit a report of the number of meters received during the year, the number set, the number now in service, the net increase in six years, and the average yearly increase. Also the number of new meters on hand this date, the number from vacant premises, also private meters in shop, the number of meters tested during the year, the number of meters repaired and the kind of repairs made, along with the different parts of meters on hand and the customary inventory.

Number of ⅝-inch meters received during the year	800
Number of 1-inch meters received during the year	18
Number of 1½-inch meters received during the year	27
Number of 2-inch meters received during the year	3
Total number of meters received	848
Number of meters set during the year	781
Total number of meters now in service	5,593
Increase Jan. 1, 1895, to Jan. 1, 1902	4,284
Average yearly increase	714
New meters on hand	148
Meters in shop from vacant premises	93
Private meters in shop	2
Grand total of all meters in shop	243
Number of meters repaired during the year without bringing to shop	632
Number of new meters tested during the year	818
Number of old meters tested during the year	14
Total of all meters tested during the year	832

METERS REPAIRED DURING THE YEAR AND THE KIND OF REPAIRS MADE.

Stopped from accumulation of rust or mud	102
Broken or defective intermediate gears or piston	68
Broken or defective dial gears	127
Injured by frost	13
Injured by hot water	15
Worn out	3
Removed on account of noisy action	3
Examined for accuracy after long use	14
Discs broken or worn out	15
Exchanged for meters of same size	22
Exchanged for meters of larger size	30
Removed on account of changing pipes	1
Stopped and needed refitting of piston or discs	2
Leaky stuffing boxes	92
Removed on account of vacation of premises	126
Grand total of all repairs	632

GEORGE DOORLEY,

Inspector of Meters.

REPORT OF CITY TREASURER.

(CITY TREASURER'S OFFICE.)

WATER DEPARTMENT FUND.

Balance Jan. 1, 1901		$20,084.03
Receipts, 1901		301,938.50
Disbursements, 1901	$305,217.14	
Balance Jan. 1, 1902	16,805.39	
	$322,022.53	$322,022.53

WATER BOARD SINKING FUND.

Balance Jan. 1, 1901		$30,439.11
Receipts, 1901		102,777.39
Disbursements, 1901	$129,247.98	
Balance Jan. 1, 1902	3,968.52	
	$133,216.50	$133,216.50

REPORT

UPON

ELECTROLYSIS

IN THE

CITY OF ST. PAUL, MINNESOTA.

ALSO

ACTION OF THE BOARD OF WATER COMMISSIONERS

AND

OPINIONS OF THE CORPORATION ATTORNEY RELATING TO SAME.

NOV. 9, 1901.

ST. PAUL, MINN.:
THE PIONEER PRESS COMPANY.
1902.

PROCEEDINGS

OF

BOARD OF

WATER COMMISSIONERS

AT A

MEETING HELD DEC. 23, 1901.

On motion, duly seconded, the following resolution was unanimously adopted:

By J. M. Carlson:

"*Resolved*, That the secretary be directed to have published in the report of the investigations made by the committee appointed by the board on April 27, 1899, for the purpose of ascertaining to what extent said mains and pipe were affected by electrolytic action, all of the proceedings of the board in the past relating to this subject and the opinions of the corporation attorney on same."

RESOLUTION OF BOARD SEPT. 25, 1893.

By Thomas Grace:

"WHEREAS, It is ascertained that the Twin City Rapid Transit Company have, without authority, connected the return ground wire with the water mains and fire hydrants of this department,

"*Be it resolved*, That the secretary be instructed to request the aforesaid street railway company to furnish this board forthwith with a list of all such connections and their exact locations, and, also, as near as may be, the date when such connections were made, for the information, guidance and future action of this board.

"And if this request is not immediately attended to and correct information given, that the corporation attorney be instructed to take proceedings immediately, under section 18 of 'An act to amend and consolidate an act to authorize the city of St. Paul to purchase

the franchises and property of the St. Paul Water Company and creating the Board of Water Commissioners, approved Feb. 10, 1887, and the act amendatory thereof, approved the 25th day of January, 1883,' and again amended March 4, 1883."

ST. PAUL, MINN., Sept. 27, 1893.

Frank S. Hoskins, Supt. Twin City R. T. Co.,

DEAR SIR: You are hereby requested to forward to this department, at your *earliest possible convenience*, the information requested in the following resolution, which was unanimously adopted at a meeting of the Board of Water Commissioners held on the 25th inst., and oblige,

Yours respectfully,
JOHN CAULFIELD,
Secretary.

ST. PAUL, MINN., Sept. 29, 1893.

Mr. John Caulfield, Secretary Board of Water Commissioners, City,

DEAR SIR: Replying to yours of September 27th, I find that at the present time we have no ground wire connections with the city water mains. That a short time ago, the exact date I am unable to give, we made a connection from our track feeder to the water pipes at Selby and Milton streets. This has since been disconnected.

In making the connections at Selby and Milton streets we supposed it was with the knowledge and consent of the Board of Water Commissioners, and I was only notified a few days ago to the contrary by the superintendent of the water works. We will not in the future make such ground wire connections with the water mains, as per your instructions.

Yours truly,
F. S. HOSKINS,
Superintendent.

From record of board meeting April 26, 1899.

"A communication was received from the general manager of the Rapid Transit Company with reference to the sub-station which they are constructing at the corner of Dale street and Aurora avenue, stating that their object in putting in a large iron water connection was to prevent electrolysis. This communication was in reply to a letter of the secretary stating that he was informed that the object of this pipe was to act as a return conductor through the

water mains. This matter was referred to a committee, consisting of the engineer and superintendent, to investigate and report what, if any, action is necessary to prevent injury to the water system."

From record of board meeting May 31, 1899.

"The secretary was directed to request the superintendent and city engineer to report as early as possible on the request of the board of April 26, 1899, in the matter of electrolysis."

From record of board meeting October 31, 1899.

"The secretary submitted correspondence from the Twin City Rapid Transit Company in the matter of connecting wires with the water service in its power house, No. 462 N. Dale street. The action of the secretary in ordering the wires disconnected was approved, and the Rapid Transit Company to be notified of its action."

ST. PAUL, MINN., Oct. 5, 1899.

Dow S. Smith, Esq., Supt. T. C. R. T. Co., City,

DEAR SIR: Your attention is respectfully called to the following report submitted to me this day by our meter inspector, with reference to your having connected the electric wires to the water service:

"ST. PAUL, Oct. 5, 1899.

"John Caulfield, Secy. Board Water Commissioners,

"DEAR SIR: When about to set the water meter on the 2-inch water supply to the Twin City Rapid Transit Company's house, No. 462 Dale street, application 9314, it was discovered that one of the electric wires was attached to the water supply to the building. The man in charge informed your men that he would disconnect the wire while the meter was being set. Now, what the object in having the wire connected to the water pipe is I cannot say, but I do say that this city is almost free from electrolysis on the water mains, and, should this wire be connected as it was, electrolysis is bound to ensue at some point or other in the neighborhood of this electric house. It may not occur for some time, but when it does the effect will be such that will surprise the best informed electrical engineers, as was the case in Kansas City, which has at the present time a number of miles of street mains in danger of going up at almost any minute, according to the report of ex-

perts who made an examination of the street mains of that city. The connection of that wire with the water mains of this city should not be tolerated.

GEO. DOORLEY,
Inspector."

Connections of this kind are positively prohibited, and I desire to have the wires disconnected at once. We have had a similar case in the Dispatch building, in which the meter was so charged that we could not disconnect it. After some controversy, we ordered the wires disconnected, which was done.

Very truly yours,
JOHN CAULFIELD,
Secretary.

MINNEAPOLIS, MINN., Oct. 25, 1899.

John Caulfield, Secretary Board of Water Commissioners, St. Paul, Minn.,

DEAR SIR: Relative to the situation of our Dale street station: I have tried two or three times to see you. At the time of our last talk you suggested that I see Mr. Claussen. It is his opinion that the plan which we have adopted at this point is the proper course to pursue; and from this I assume that he would not recommend disconnecting your pipes.

If you wish to make any personal inspection, or desire any tests made, or if there is anything further in the way of information which you desire, if you will kindly communicate with me, I will arrange for the same at an early date.

Yours truly,
WILLARD J. HEILD,
General Manager.

Board meeting Oct. 31, 1899.

Action of secretary approved and electric wire to be disconnected.

JOHN CAULFIELD,
Secretary.

From record of board meeting October 9, 1900.

"A communication was received from John Lindquist, superintendent, to the effect that the City Railway Company had connected their electric wires with the iron stop-boxes at No. 56 and No. 58 East Fifth street and that the damage was done to said stops by electrolysis having melted away the largest portion of soldering and brass, and that the expense of same was $18.57.

"A communication was received from George Doorley, meter inspector, stating that the City Railway Company has an electric wire connected with the 2-inch service at the transforming house, No. 462 Dale street, register 3976. Also, that at the Hill street power house the pipes are charged with electricity and one of the water works employes received a shock while connecting up the temporary supply on July 5th. He also reported that the Northwestern Telephone Company has an electric ground wire connection attached to the water pipe at No. 623 Laurel avenue.

"At the suggestion of A. J. Stobbart, assistant corporation attorney, the secretary was directed to send the bill for repairing pipes to the St. Paul City Railway Company, and the communications to the corporation attorney, so that an examination and report could be made as to the authority of these companies to make connections with water pipes and to suggest some remedy for same."

From record of board meeting November 22, 1900.

"A report was presented by A. J. Stobbart, assistant corporation attorney, upon the request of the board, at a meeting held on October 9th, as to the authority of the City Railway Company and other companies to make electric connections with water pipes. Received and placed on file and the secretary directed to serve formal notice on the various companies using water pipes for return currents, requiring them to disconnect any wires that are now connected and forbidding them to make any connections in the future."

REPORT OF A. J. STOBBART, ASSISTANT CORPORATION ATTORNEY.

ST. PAUL, MINN., Nov. 19, 1900.

Mr. John Caulfield, Secretary Board of Water Commissioners, St. Paul, Minnesota,

DEAR SIR: I am in receipt of your letter of October 10, 1900, with accompanying letter copies and documents relating to the

destruction and injury to water mains and supply pipes by electrolysis, and requesting therein an opinion as to the authority under which the railway or other companies make connections with the water system, whereby injury from this course is sustained, and also as to the general rights of the Board of Water Commissioners to prevent the making of connections above referred to in the future, and also to compel the adoption of such a system or systems by the companies whose plants are the cause of the injury as will prevent this destructive element.

The request above referred to can be divided into two questions, viz.: First—By what authority these companies make such connections, and to suggest some remedy therefor; and, second—What should be done by the Board of Water Commissioners looking to the prevention of this electrolytic action upon the mains and supply pipes.

In answer to the first query, I beg to advise you that these companies have absolutely no right to connect any part of their plant or plants used, with any of the mains, supply pipes or equipment of the water department, and it is doubtful whether your honorable board even has the right to grant permission to them so to do, in view of its knowledge of the effect of electrolysis. As to the prevention of such connections, I would advise that your board notify each of the offending companies to immediately discontinue any connections so made, and to desist from making any such in the future, and in case said demand is not strictly complied with, that then the board will be compelled to resort to legal resources to fully and substantially protect its rights. There is absolutely no question as to the legal rights of your board hereunder, and in view of the probable dangerous results attending such connections, it would be fully justified in adopting the measures suggested.

As to the second query, it involves some grave questions, and merits a very thorough investigation, both from a practical and legal standpoint. I have examined with considerable care the numerous pamphlets and correspondence submitted, and from my investigation I assume that, while some of the trouble may be caused from telephone and electric lighting plants, the most serious difficulty is brought about by the street car system. I take it that in the single trolley system, which is in operation in this city, the power used to operate the motors under the cars is conveyed to

them by a single overhead trolley wire and a single arm or pole attached to the car and carrying a contact wheel, which runs along and presses up underneath the trolley wire. The current passes down the pole or arm to the switch apparatus on board the car, through the motors, thence to the wheels and to the tracks. It then passes back to the station along the iron rails of the track, interlaced together by conducting wires, and firmly connected by a conducting wire with the negative pole of dynamo, the greater portion of the current flowing along this line of the track as the return current. That the current traverses the rail until it reaches a point of less resistance when it leaks into the latter and travels therein to the next point of less resistance. That the water mains and supply pipes of your board offer less resistance than the rail, and they therefore become the medium of return, but that no apparent damage results at the point of entrance; that where the moist earth surrounding said mains and pipes offers less positive resistance than the mains or pipes, the tendency then exists for the current to flow from them into the earth, and at such point electrolysis is produced. That the extent of corrosion through electrolysis depends largely upon the nature of the soil surrounding the pipes, and is, of course, affected by the amount of current then flowing, but the authorities seem to be agreed that the danger exists in some degree. It is also indicated that the passage of the current through the mains or pipes causes internal corrosion, although in a less degree than at the point where the current leaves the same, and that the results of electrolysis on wrought iron and lead pipes are more pronounced than in cast iron pipes. Some of the authorities submitted intimate that a great deal of the trouble could be overcome if the connections between the rail ends, which are called "bonds," could be kept perfect and were of the latest improved design, but this claim is controverted by the statement that even cast-welded rails feed heavily into the water mains in some cities.

It would seem, however, that the danger can be overcome only by the adoption of the so-called double trolley system, by which two trolley wheels are used in connection with two wires. The current passes from one wire, through one trolley and into the motor, from which, instead of passing into the wheels, it passes through the other trolley into the other wire and back to the generator.

There can be no doubt about the legal liability of the company for any damages done by its electric current, but a prevention of any damage is the thing desired, and particularly in view of the fact that the water mains and supply pipes of your board are not susceptible of frequent examination, and the importance of a constant and full supply of water to the inhabitants of this city is greater than the necessity for a street car service.

It is my opinion, therefore, that your board should cause an immediate investigation to be made of this matter, including a complete electrical survey of the mains and supply pipes of the city's water system, and to secure such facts relative to damage already sustained from this cause as it can, and also ascertain what changes should be made in the present system of the street car company to prevent the difficulties complained of, and thereafter to serve a formal demand on the street car company to make the necessary changes, and in case said company fails, within a reasonable time, to perfect such changes, then to submit the matter to this department, with the request that such necessary legal steps should be taken in order that the property of the water department may be fully protected.

Very respectfully,
ARTHUR J. STOBBART,
Asst. Corporation Attorney.

On May 7, 1900, a voltmeter was purchased registering to 50 volts.

From record of board meeting December 31, 1900.

By R. B. C. Bement:

"*Resolved*, That a test for electrolysis be made in addition to lines upon same streets as pipes and rails are laid, not less than one-fourth mile from street railway tracks, and that, in the opinion of the board, it is expedient to procure a dead-beat voltmeter, reading on the high scale to not less than 100 volts and on the low scale to 20 volts, equipped with switch changing from high to low meter and changing poles.

"For reason of this, attention is called to tests made in other cities, and it is our desire to make thorough and complete tests, to the end that the water mains shall be protected."

On February 22, 1901, a 100-volt meter was purchased from Weston Electric Instrument Company.

From record of board meeting May 31, 1901.

"Assistant Corporation Attorney Stobbart called the attention of the board to a recent report filed by Special Master in Chancery Frank L. Wean to Judge Grosscup of the United States Circuit Court in the noted Peoria Electrolysis case of the Peoria Water Company against the Central and the Peoria and Prospect Heights Railway companies, which was published in the *Dispatch* May 30th. After some discussion, it was moved and seconded that the secretary be directed to notify the committee, consisting of the city engineer and superintendent, which was appointed by the board on April 26, 1899, to investigate this subject, to submit a report to the board at a meeting not later than June 30, 1901."

From record of board meeting November 11, 1901.

"The city engineer submitted a report upon the investigation which he has had on the action of electrolysis on water pipes by the street railway's system, which was referred by the board to a committee consisting of the superintendent and city engineer, at a meeting held on April 26, 1899. The same was accompanied by a map showing the whole pipe system and photographs of injured pipes. The report was referred to the corporation attorney."

REPORT OF OSCAR CLAUSSEN, CITY ENGINEER.

ST. PAUL, MINN., Nov. 9, 1901.

To the Board of Water Commissioners, City of St. Paul, Minn.,

GENTLEMEN: As you have been well aware, I have had under way for some time an investigation of the effects of electrolysis on the water piping system of this city, which, now that it is completed, will put your honorable board in possession of facts that are of great interest not only to you but to every citizen of the city of St. Paul. Inasmuch as this investigation has received considerable of my personal time and attention, it has taken some time to gather together all the data, but the report that I submit herewith is quite exhaustive and establishes beyond doubt the fact that electrolysis, or, in other words, decay of water pipes, from the effects of stray electric street railway currents, exists in all parts of the city of St. Paul.

In order to arrive at the proper data, an electrical survey was made of the entire city, consisting of electrical measurement tests, principally voltmeter tests, along about forty-three miles of double and fifteen miles of single track operated by the Twin City Electric Street Railway Company on the single trolley system, also the water piping of a number of streets running parallel to and under right angles to the different street railway lines. Excavations were made at various points throughout the city for the purpose of examining the physical condition of the water pipes, and samples of the portions of the pipe and the earth surrounding same were subjected to chemical analysis. As much of the above data as possible were platted on a large map, scale 1,000 feet to the inch, which map accompanies this report and is made a part thereof. The map will expain itself, as a key to the various data of interest is given on the upper right hand side of the map. The chemical analyses were all made by Prof. George Weitbrecht, and his report to me is made a part of this report and hereto attached. The several measurements were made by my assistant, Mr. Edmondstone, who was in general charge of the investigation, acting under my instructions. I desire to thank your honorable board, your secretary, Mr. Caulfield, and your superintendent, Mr. Lindquist, for the liberal support and assistance that were rendered my department in carrying on the investigation and I hope the report submitted may be of some practical value.

As you are aware, and a glance on the map will show, the city is traversed in all directions by street railway lines which are operated by one company, viz., the Twin City Rapid Transit Company. This company derives the power for propelling its cars from water power located at Minneapolis, from where the current is transmitted, under a pressure of 12,000 volts, to two substations in St. Paul, one located at the corner of Dale and University and one located on Hill street near Eagle street, close to the Mississippi river. The alternating current, received under high pressure at these two substations, is then transferred by means of rotary transformers into a low pressure direct current, suitable to send out throughout the city on overhead lines to supply the electrical energy used up by the direct current motors propelling the cars. The electrical current that leaves the pole of the dynamo, or rotary transformer in

our case, after passing through the motor, returns by law of nature to the negative pole of the rotary transformer. The same amount of current that leaves the station returns to the same, the current is not used or destroyed. It does work in connection with the voltage only, and it is only the voltage or electrical pressure that is eaten up when work is performed by the combined agency or voltage current. The full amount of current, after leaving the motors, goes through the car axle and car wheels to the rails, and from there back to the power station. The current in traveling back to the power house will leave the rails at any point or moment and enter other available conductors, the current being divided up, depending upon the relative conductivity of the various paths offered. Once the current leaves the car wheels, the paths over which the current may travel are many, the rails, the natural ground, water piping, gas piping or any other conductor that may be in the street not insulated. Water piping generally being of large dimensions and a good conductor, and therefore offering little resistance, makes a very available path for the current to travel on, especially if the rail at that point is of small cross-section and poorly bonded. The current, when leaving the rails and entering the water pipe conductor, will do no harm, but when leaving the water pipe, either going back to the rail or entering some other conductor, it will develop electrolysis—that is, it will decompose the pipe at that point by freeing the iron. Inasmuch as Professor Weitbrecht has fully explained the action of the current on the pipe, known as electrolysis, I will not go into this matter in detail, but refer you to his report, hereto attached.

Whenever it is shown by voltmeter tests that a difference of potential or electrical pressure exists between the rail and the water pipe, a current is known to be set up between the two. If this current leaves the pipe for the rail, the pipe is positive to the rail and the rail negative to the pipe. If the current leaves the rail for the pipe, the rail is positive to the pipe and the pipe negative to the rail. On the map, all voltmeter readings indicating that the pipe was positive to the rail were marked in red ink, all others where the rail was positive to the pipe in black figures. Wherever you see red figures, therefore, on the maps, current is leaving the pipe and the conditions for electrolysis are fulfilled. There are, however,

other places in the various pipe lines where electrolysis exists, and that is at the joints. When an electrical current travels along a pipe line it will find considerably more resistance to its passage at the joints than at any other point, on account of the imperfect contact between the spigot and the bell end of the pipe. Depending on the amount of this resistance, either part or all of the current will leave the pipe, seeking its path through the surrounding soil and re-enter the next pipe length, thus creating electrolysis at the point where it leaves the pipe. Inasmuch as a certain amount of electrical current is set up at all places where voltmeter readings are indicated on the map, electrolysis must be anticipated at all these points, primarily and distinctly at all such points where red figures are displayed or where the pipes are positive to the rails, but also in some degree at all such points where black figures are displayed or where the rails are positive to the pipe, and where a current is thus shown to flow along the pipe line injuring the pipe line at the joints. Under these conditions electrolysis will therefore exist over a very large territory of the water piping system, the size of which is easily observed by a study of the map. As will be observed, some extremely high volt-meter readings were ascertained. At some places on the outskirts near the end of some lines voltmeter readings were had as high as from 50 to 80 volts, rails positive to pipe, indicating that the waste of energy and leakage of current is very great and revealing also the fact that the rails are improperly or not at all bonded or of insufficient cross-section. Near the substation power house, corner of University avenue and Dale street, and on Hill street, the pipe positive district is very pronounced, the pipes at some places being as much as 17 volts positive to the rails. With regard to the readings, they are given on the map from 0 to maximum in each case. The readings would vary greatly in most cases, depending on the momentary loads, the proximity of cars, up or down grade, condition of rail, etc. Especially was this the case with readings showing the rails positive to the pipe. It is perhaps well to state here that the conditions creating electrolysis are constantly changing on account of the addition in trackage, changes from poor to good construction, deterioration of bonds and tracks and change in power distribution, etc. The present power distribution from the substations dates back about three years. Before that time there was no power sta-

tion corner of University avenue and Dale street. For these reasons the electrical survey as put before you will not reveal any weak spots in pipe lines caused by electrolysis in former years that might have taken place at such places that to-day show no danger as far as an electrical survey would indicate. The physical examinations made of the pipe line at such places where excavations were made all show the characteristics of electrolysis. None of these excavations, however, have produced evidence that the main pipes are seriously injured. While the injury was quite uniform, the decay of main pipe extended at no place, as far as could be observed, to any material depth, and no pipes were discovered that were eaten through, although you will remember that your superintendent has heretofore replaced leaky pipes that exhibited evidence of electrolytic action on them. That lead service pipes, however, are destroyed right along there is no doubt. From Professor Weitbrecht's report you will learn that the various chemical analyses made by him show conclusively that electrolytic action is gradually destroying the pipe system. It is impossible to state the amount of damage done in dollars and cents or to predict how soon serious trouble with the water piping system will develop, but that accumulative damage is caused to the system is clearly demonstrated by the various tests. With regard to the chemical tests the amount of moisture as given is deceptive. In most cases the material surrounding pipe at points of excavation was quite moist and considerable of this moisture evaporated before the sample reached the chemist. In most cases, too, the accumulation of deceptive material was found on the bell end of pipes. The fact that not more deterioration is shown is partly due to the fact that the water pipes are laid rather deep in the ground, usually seven feet deep, and on account of the distance from the rail the current will find more resistance than if the rails and pipes were closer together, such as is the case in cities further south.

As to the remedies to be applied to prevent electrolysis there appears to be but one radical solution, and that is to compel the Street Railway Company to use a complete metallic circuit, insulator from the rails and ground, providing a conductor for the return of the current to the substation rotary transformer as perfect as the conductor that is provided to supply the energy along the

street railway lines for driving the motors. I understand that this is being done in places, notably in New York City and in Washington, D. C., by means of the underground conduit system, and in Cincinnati, Ohio, and on suburban lines in the District of Columbia, by means of the double overhead trolley system. Both of these systems provide for an independent conductor for the return of the current to the generator, being insulated completely from the rails and the ground. In the meantime and until this is done, conditions will be materially bettered if the Street Railway Company will maintain its tracks in first-class condition, put in large rails and welded tracks, or, where the track is not welded, install and maintain proper bonds of electrical carrying capacity same as the rails.

The following data will show in detail the various tests made, following the course of the various street car lines and noting the salient features, also description in detail of the various excavations made and concluding with the report submitted by Prof. George Weitbrecht.

REPORT UPON ELECTROLYSIS.

Examinations were made upon one line, Concord and South Robert streets, from Nov. 20 to 27, 1900, inclusive. Temperature about 10 degrees F.; cloudy; connection between rail of street car company and hydrant. Commencing at Concord and Kansas streets, the voltmeter read from 70 volts upon Anita street to 35 volts at Robert and Congress streets, with the street car rail positive. At Robert and Isabel streets, the meter read from 0 to 30, with rail positive, and changing poles 0 to 4 volts, with pipe positive. The first-named reading occurred when a car was approaching and the last-named when the car neared the end of the line. Proceeding north on Robert street, the rail positive readings continued to decrease whilst the pipe positive increased, the duration of the latter readings being much longer than the former, until when the bridge over the Mississippi river upon Robert street was reached, the rail positive readings ceased altogether, and while the pipe positive readings were low, they were constant. The bridge over the tracks of the Chicago, Great Western Railway developed from 1 to 2 volts with bridge positive. Since the readings have been taken the above bridge has been stripped and the iron work is shown to have been injured, partly, of course, by the action of coal fumes, but presumably assisted by electrolytic action. The bridge over the Mississippi river also is positive to the rail, and when next the bridge is scraped for painting it may show serious deterioration.

Only a few readings were taken upon State street, all showing rail positive from 35 to 50 volts. The State, Concord and Robert street lines are all old type of rail, and but poorly bonded at joints, readings between joints in several instances showing as much as 0.3 volt.

West St. Paul Line, Including Stryker Avenue Branch.—Temperature about 20 degrees F.; snow upon ground; date, Nov. 27 to 30 inclusive, 1900; cloudy. Connection between rail of the street car company and fire hydrant. Commencing at Smith avenue and Morton street the voltmeter read from 15 to 48 volts.

Upon Morton street, 0 to 8 volts. On Winifred and South Wabasha streets, with street car rail positive. Upon Stryker avenue the voltmeter read from 0 to 10 volts. On Winifred street 0. to 35 volts, on George street, with street car rail positive. Upon South Wabasha and Congress streets the voltmeter read 0 to 7 volts with street car rail positive and changing poles 0. to .5 volt, water pipe positive. From thence northerly to the Wabasha street bridge over the Mississippi river the rail positive readings decrease in intensity and duration and the pipe positive increase.

Readings upon the Wabasha street bridge and the 16-inch water main suspended thereunder, made Aug. 16, 1901, give a reading of both bridge and pipe positive 1.5 volts, maintained almost constantly and with an ammeter reading of constantly 4.1 ams. The ammeter being connected between rail and pipe and rail and bridge, this condition is liable to affect the life of the bridge floor. As a matter of interest, it may be stated that the old Wabasha bridge, recently replaced by the present structure, showed decided electrolytic action. The West St. Paul and Stryker avenue lines are of the old type of rail, imperfectly bonded at joints.

Lafayette Avenue Line.—Commencing at hydrant, corner of Maryland and Payne avenues, temperature, about 32 degrees F.; clear; date, December 1st to 4th, inclusive. Connection between street car rail and fire hydrants. Commencing at fire hydrant, corner of Maryland and Payne avenues, the voltmeter reads 0. to 18 volts and 0. to 8 volts on Greenbrier and York streets, rail positive, at which latter place a trace of current pipe positive was found. From thence, approaching the heart of the city, the rail positive readings decrease in intensity and duration while the pipe positive readings correspondingly increase; however, the pipe positive readings are not high, and, as will be shown later in this report, the current apparently passes from the rail into the pipe and from the pipe into the rail of the street car company on Jackson street. The joints are not well bonded in many instances, though somewhat better than the lines before examined. As high as 0.3 volt difference in potential being observed between joints. Two steel bridges are crossed by this line of the railway company—Lafayette avenue and Payne avenue. Upon the former the voltmeter reads from 2 volts, rail positive to bridge, 0.7 volt, bridge positive to rail, and in the

latter from 0.4 volt, rail positive to bridge, and 0.5 volt, bridge positive to rail.

Mississippi Street Line.—Which, from Tenth street to Seventh street on Broadway, also carries the Lafayette avenue cars, and from Seventh and Broadway to Fifth and Robert streets, in addition, carries the east-bound Stillwater, Wildwood and Maria avenue cars, and from Sibley to Robert on Fifth street, carries the west-bound Union depot loop cars, and from Jackson to Wabasha street, carries the west-bound Jackson street cars. Temperature, 5 degrees F.; date, Dec. 6 and 7, 1900. Connection between street car rail and fire hydrant. Commencing at Arkwright and Geranium streets the voltmeter reads from 0. to 50. volts and from 0. to 44. volts on Arkwright and Case streets, with the street car rail positive. At Westminster street and Lookout place the voltmeter reads from 0. to 28. volts, rail positive, changing poles and reading from 0. to 2. volts, pipe positive. From thence toward the center of the city the rail positive voltage decreases in intensity and duration and the pipe positive voltage correspondingly increases, until, at the hydrant upon the southwest corner of Sibley and Fifth streets, all trace of rail positive ceases. It is well to note that decisive readings of rail positive cease upon Mississippi street and Pennsylvania avenue, while the pipe positive readings increase. From Jackson street to Robert street the readings are all pipe positive—about 0.7 volt—and while low show the direction of the current. From Geranium street to Broadway the rail joints are but imperfectly bonded, but from thence on toward the city the street has been paved and joints are good. An excavation on this Mississippi street line, about 55 feet north of Grove street, was made on Nov. 26, 1900. A leak had occurred in the joint of the 30-inch water main and trouble had been experienced at this place two years before. The pipe is located almost directly under the west rail of the track at a depth of about 6 feet. The pipe was covered with the usual incrustation, which could easily be knocked off, the asphaltum appearing to be intact. Unfortunately, no samples of the incrustation were taken nor the pipe covering subjected to a close scrutiny; however, the same conditions existed there that at other points, upon closer examination, were recognized as electrolysis. Voltmeter readings between spigot end of pipe and street car tracks, 0.7 volt; between bell end of pipe and street car track, 1.7

volts; between bell and spigot ends of pipe, 0.6 volt; between pipe and earth, 0.2 volt; soil, sandy loam. The leak was apparently caused on account of the distribution of the lead caulking.

Maria Avenue Line from Indian Mounds Park to Seventh Street.—Temperature, about 15+ degrees F.; snow upon the ground; clear; date, Dec. 19, 1901. Connection between fire hydrants and street car rail. Commencing at Thorn and Earl streets, the voltmeter reads from 0. to 8. volts, on Burns and Earl streets from 0 to 1. volt on Hastings and Earl streets, rail positive. From Hastings and Earl streets to junction with the Seventh street line, the rail positive readings do not exceed 5. volts at any point, but the poles change to pipe positive during about one-half the time. The highest reading with pipe positive occurred at Maria and Third streets and was 1.8 volts; from thence it varies to 1 volt. The northern portion of this line is well bonded and no perceptible difference between rail ends was noticeable, but, toward the Indian Mounds a difference of .1 volt was found between rail ends.

Jackson Street Line from Northern Terminus to Fifth Street.—Temperature, about 10+ degrees F.; clear; snow upon the ground; date, Jan. 28 and 29, 1901; connected between fire hydrants and street car rail. Examinations upon this line presented peculiar features, in that the meter poles changed, generally reading pipe positive, changing over to rail positive, but so remaining for only a short portion of the time observed. The whole of the ground and surrounding metallic objects seem to be charged with electric current, vibrating from pole to pole, but the major portion of the current passes from the pipe to the rails. Readings taken upon trolley poles, gas lamp posts, gas mains, water works valve boxes and the bridge over the Great Northern Railway tracks upon Jackson street, all exhibit the above mentioned conditions, and upon exposing portions below the surface of the ground a very decided electrolytic action is perceptible.

Except upon the more recently paved streets where the street car rails have been relaid, the rails are very poorly bonded, in some instances developing 0.5 volt between rail ends. From Arch street towards the center of the city, barely any rail positive readings were obtained, and they so small and of such short duration as to be of but little influence. The general reading was about 3 volts pipe positive.

Robert Street Loop.—Commencing at Fifth and Robert, thence north on Robert, west on Eighth, south on Wabasha and east on Fifth to point of beginning. Temperature, about 20+ degrees F.; snow upon the ground; date, Jan. 29 and 30, 1901. Connection between street car rails and fire hydrant. With the exception of the Seventh street and Fort Snelling cars and Selby avenue car line, all the street cars which enter the city pass over this line or portions of it, following each other in very rapid succession.

The readings recorded upon the voltmeter show pipe positive constantly, the needle never returning to zero. The readings run from 0.2 to 1.1 volts, low readings to from 0.9 to 3. volts, high readings at the various points. Rails are well bonded and barely perceptible leakage of current at joints. This, however, only emphasizes the fact that, no matter how well bonded, there is a perceptible leakage.

Seventh Street Line.—Temperature, +08. degrees F.; snow upon the ground; date, February 1st to 8th, inclusive. Connection between street car rails and fire hydrants. Commencing at fire hydrant corner of East Seventh and Phalen streets upon the Stillwater line, voltmeter reads 7.3 volts with real positive, continuing so to English street and maintaining an average low reading of 3.0 volts and showing no trace of pipe positive. Reading upon first hydrant west of English street, which stands nearly in front of No. 1223 East Seventh street, showed reading of 0. to 4.8 volts, rail positive and changed poles, reading of 0. to 2.3 volts, rail positive, continuing in about this intensity to Seventh and Duluth streets, from whence the Fort Snelling and Seventh street cars start. From thence westerly, the rail positive readings are highest and of longest duration, reaching as high as 12 volts, but the pipe positive readings are found at each hydrant and last about one-third of the observed period. This condition exists as far west as Maria avenue, and from thence westerly until John street is reached only traces of pipe positive could be found; the rail positive readings averaging about 3.0 volts, and remaining so during the major portion of the time observed. From Olive street to Sibley street the rail positive readings decrease and the pipe positive readings increase, until at the last-named street the rail positive readings cease altogether. From Sibley street to Walnut street no trace of rail positive could be found, and the pipe positive readings continued to increase from 0. to 1.3

volts on Sibley street to from 3.1 to 6.2 volts on Chestnut street. From Sherman street to Tuscarora street both pipe and rail positive readings were observed at each hydrant. Rail positive readings continued to increase in intensity, but no corresponding decrease was observed in the pipe positive,—to the contrary, it also increased in intensity. Duration of rail positive readings would not exceed about one-fourth of the time observed.

From the top of the hill upon East Seventh street to Ramsey street and West Seventh street the street is paved with brick, asphalt and sandstone, rails well bonded and but little escape of current at joints. However, from Seven Corners to Ramsey street, sandstone pavement was not laid until June, 1901. Readings taken prior to that time gave pipe positive averages of from 2.1 volts to 4.8 volts, and readings taken since new pavement and rails were laid give averages of rail positive of from 0. to 1.6 volts of but short duration and of pipe positive of from 0. to 0.8 volt, of duration extending over three-fourths of the time observed. Thus it will be seen that the more perfect bonding of the rails has in a measure remedied the defect, but not sufficiently to eliminate danger to pipes, especially as the old order existed for a number of years, and during that time the electrolytic action was very pronounced, as will be shown by report upon excavations further on in this report.

Seventh street bridge is crossed by this line of rails, and shows traces of bridge positive to rail of long duration and of rail positive to bridge of short duration.

Selby Avenue Line.—Temperature, above freezing; streets, muddy; clear and with high wind; date, Feb. 13 and 14, 1901. Commencing at fire hydrant at corner of Prior and University avenues and observing upon each hydrant en route until the bridge over the Chicago, Milwaukee & St. Paul Railway tracks was reached, the voltmeter invariably read rail positive, the needle never setting back to zero. The highest reading was from 4.1 to 19. volts upon hydrant Prior avenue and Iglehart street. Average reading from 3.4 to 15.2 volts. The rails upon the bridge are directly connected to the iron stringers, therefore no decisive reading could be observed, the tendency of the needle being, however, to show a trace of bridge positive. During the fall of 1900 the bridge was thoroughly scraped and repainted, and showed a very decided deterioration of the stringers; scale over an eighth of an inch in thickness

being removed from the stringers and from the floor beams, similar in its nature to the scale removed from the pipe, which has been demonstrated by chemical analysis to be "a kind of ferric cement, caused by electrolytic action."

From the east end of the bridge easterly to Dale street both pipe positive and rail positive readings were observed, the duration of rail positive being about three-fourths of the time observed. Highest rail positive reading, 0. to 38. volts at Selby and Lexington avenues; average rail positive reading, 0. to 15. volts; highest pipe positive reading, 0. to 3.1 volts at Selby and Hamline avenues; average pipe positive readings, 0. to 1.9 volts.

At Dale street the duration of the pipe positive and rail positive readings were of equal length, and were as follows: Rail positive, 0. to 9.1 volts; pipe positive, 0. to 3.3 volts. These readings were the averages of two days and extended over a period of an hour. At Dale street there is a ground connection from cables. Passing eastward from Dale street both rail positive and pipe positive readings were observed, until Pleasant avenue and Third street was reached, at which latter place all trace of rail positive ceased. From Dale street eastward the intensity and duration of rail positive readings decreased, and pipes positive readings increased. In this section the highest rail positive reading was 0. to 8.3 volts, observed at Mackubin street, and the average was from 0. to 6.8 volts. Highest pipe positive reading was 0. to 5.8 upon Summit avenue, and the average was from 0. to 3.7 volts.

From Pleasant avenue eastward to end of line near Broadway all readings were pipe positive, needle never setting to zero, and reaching the maximum of from 3. to 7.1 volts upon Fourth and Washington streets.

From Pleasant avenue westward to Fairview avenue the general construction of the line of track is that of the old cable line slot type, broken at various points where it has been necessary to make repairs. Ordinary type of joint, double track upon Marshall and Fairview avenues, and single track, ordinary joints upon Prior avenue. From Pleasant avenue eastward modern type of joints, double track, street paved with asphalt. Selby avenue as far as Victoria street is paved with cedar blocks, and the remaining portion of the line unpaved. Track from Summit to Prior avenue is in poor condition.

Grand Avenue Line.—From Catholic Seminary to Seventh street; date, February 15th to 17th, inclusive; temperature, above freezing; connection between street car rails and fire hydrants. Commencing at fire hydrant opposite the Catholic Seminary upon Grand avenue, voltmeter reads from 0. to 33. volts, rail positive, continuing so, constantly, until Lexington avenue is passed, and at the last named point reading 0. to 12.5 volts, rail positive. Groveland Park cars only run from Snelling avenue to Catholic Seminary upon a single track at about thirty minute intervals. Single track continues eastward from Snelling avenue to Syndicate avenue, and from thence eastward, double track. Bridge is of wood and iron, and is not perceptibly affected.

From Milton street eastward to intersection of Seventh street voltmeter reads both pipe and rail positive at each hydrant, the rail positive decreasing in duration and intensity, and the pipe positive increasing correspondingly. Highest rail positive reading in this section from 0. to 13 volts upon Grand avenue and Avon street; average reading from 0. to 8.1 volts. Highest pipe positive reading from 0. to 3.7 volts upon Grand avenue and Grotto street; average reading from 0. to 2.2 volts.

Streets are paved from Seventh street to Grand avenue and from thence westward are unpaved. Rails are well bonded upon paved streets, but from thence on only imperfectly so.

University Avenue (Interurban) Line.—From near westerly city limits to Rice street; date, from March 11 to 29, 1901, inclusive; temperature, above freezing. Connections between street car rails and fire hydrants. Cars run at short intervals, traffic heavy. Commencing at fire hydrant corner University and Cromwell avenues and extending easterly to University and Fairview avenues, the voltmeter reads both rail positive and pipe positive; the rail positive increasing in intensity and duration until the last named point is reached, where all traces of rail positive cease. Average reading rail positive 0. to 4.2. Average reading pipe positive 0. to 4. volts. The rail positive readings were only observable when street car was within one block, and remained so for only a small portion of the time observed. The pipe positive readings fluctated a great deal, but remained positive nearer the higher reading during the major portion of the time observed.

At Wheeler avenue, voltmeter read from 1.5 to 4.6 volts, pipe positive, increasing regularly until Dale street, at which point readings were from 4.8 to 16.7 volts, pipe positive; from thence they regularly decrease until at Rice street readings were from 1.3 to 5.8 volts, pipe positive.

At Dale street, less than one block south of University avenue, the rotary transformers are located, and it is at this point the pipe positive readings are highest. At Kent street a reading was taken between electric trolley pole and street car rail, giving 16.7 volts, pole positive; and between fire hydrant and pole gave a reading of 1.4 volts, with pole positive. Readings were taken at various places upon the gas lamp posts, and in each instance gave very nearly the same readings as were observed upon the fire hydrants.

Hamline Line.—From Snelling avenue bridge to University avenue line at Lexington avenue; date, June 4, 1901; temperature, 70 degrees F. Connections between street car rails and fire hydrants. Cars upon this line pass over the tracks of the University avenue line until Lexington avenue is reached, thence over very poorly constructed tracks on unpaved streets to Snelling avenue bridge. Commencing at Snelling avenue bridge, the following are the readings, in every instance rail positive: Bridge, 0. to 32. volts; Front street, 1. to 61. volts; Taylor avenue, 1. to 68. volts; Hewitt avenue, 1. to 66. volts; Wesley avenue, 1. to 65. volts; Capitol, 1. to 80. volts; Minnehaha street, 0. to 22. volts, and Minnehaha and Asbury avenues, 0.2 to 24 volts. From Minnehaha street and Simpson avenue to the intersection with the University avenue line, the rail positive readings decrease until there is only the trace of current at Lexington and Charles streets, and only 0. to 2. volts at Lexington and Sherburne avenues. The pipe positive corresponding increases to from 1.2 to 6.4, maintaining pipe positive during the greater portion of the time observed.

Como-Harriet (Como Interurban) Line.—Date, June 5 and 6, 1901; temperature, 80 degrees F.; dry. Connections between the fire hydrants and street car rails. Commencing at hydrant at Carter avenue and County Road and passing eastward toward center of city of St. Paul, the voltmeter gave readings at each hydrant of both pipe and rail positive, averaging about 4 volts, rail positive, and changing to an average of about 3 volts, pipe positive, each about of equal duration during time observed. This condition continued

until Western avenue was reached, save that the bridge over the tracks of the Great Northern Railway Company upon Como avenue was constantly positive to the rail .2 volts. At the intersection of Dale and Como avenues there is a ground connection from the Aerial cable, presumably a return to the rotary transformers. From Como and Virginia avenues to Rice street there are but faint traces of pipe positive, though the rail positive reading at Claghorn and Como reached 27. volts. The average rail positive reading was about 10. volts.

Apparently this line is well bonded, no portion of it being on paved streets, however. Traffic is comparatively heavy upon each car, which, under ordinary circumstances, are about fifteen minutes apart. During the week of the State Fair, September 1st to 7th, the traffic was very heavy, cars during some portions of the day running at less than three minute intervals. Examination made September 4th at 3 p. m., gave readings from 4.5 to 19.5 volts, corner Dale and Como, pipe positive, and from 23 to 51 amperes, higher readings predominating. It is well to call attention to the fact that this line is best patronized at night during the summer months, and though no observations have been taken at that time, it is a safe inference that very nearly the same readings as recorded for September 4th would be reached.

Rondo Line.—Date, June 7, 1901; temperature, 80 degrees F.; clear and dry. Connections between fire hydrants and street car rails. This is a poorly bonded track, laid upon an unpaved street until Tenth street is reached, from which point it is modern equipment. From the commencement upon Rondo and Avon until Tenth and Wabasha streets are reached readings upon every hydrant gave rail positive readings—from 0.3 to 12.3 upon Arundel street being the highest and an average over the whole line of about 4.5 volts. But scattering traces of pipe positive were found until the corner of Tenth and St. Peter streets was reached, at which point the voltmeter read 0. to 1.2 volts. From thence to Wabasha street the readings averaged 0. to 0.4 volt, and all pipe positive readings were of shorter duration.

Rice Street Line.—Date, June 7, 1901; temperature, 80 degrees F.; dry. Connection between fire hydrants and street car rail. Commencing at Rice and Jessamine streets and continuing to

Hatch street, the average is from 1. to 25. volts, pipe positive. From Front street to University avenue the street was torn up for the purpose of relaying new rails and paving the street with asphalt; therefore all readings were taken upon the temporary track which has now been replaced with the rails, welded joints, concrete foundation. The average reading upon temporary track was 35 volts, rail positive, though at end of temporary track upon Como avenue and Rice street voltmeter read 100.+ rail positive.

Upon temporary track, laid near west curb of Rice street from Como avenue to University avenue, voltmeter read from 1.4 to 18.2 volts, with pipe positive, averaging about 12 volts. This track from University avenue to Hatch street has been replaced with new rails, as above noted, and whilst much better than formerly, there is still an escape of current.

During the time that Wabasha street was being repaired all Interurban, Rice street and Hamline cars passed over a temporary track upon Rice street from University avenue to Rondo street. The voltage upon this line ran from 2. to 21. volts, pipe positive, changing poles at Rice street and Martin, and becoming rail positive about 7 volts. This track has now been removed.

Wabasha Street Line, from Eighth Street to Rice Street.—Date, June 8 to 20, 1901; temperature, 80 degrees F. Connection between fire hydrants and street car rail.

It is to be regretted that no readings had been taken upon Wabasha street from Rice street to Tenth street prior to the laying of new rails, but some estimate can be formed of the condition by reference to line between Eighth and Tenth streets. From Eighth to Tenth street voltmeter reads, both rail and pipe positive, about 1 volt in each case and equal in duration, depending somewhat upon traffic. From Tenth to Rice street connection being made to new welded rail, only bare traces of rail positive could occasionally be found. Pipe positive readings were constant, ranging from 0.8 to 2 volts.

This completes the voltmeter survey of the streets along which street car tracks are laid, but for further information readings were taken along streets at right angles to some lines and parallel to others and the following conditions found:

Victoria Street, from University to Lincoln Avenue.—Date, Aug. 27, 1901; dry and hot. One wire on University avenue

tracks and one on fire hydrants. Along Victoria, from University avenue to St. Anthony avenue, voltmeter reads pipe positive about 10 volts, closing with 10.8 volts upon St. Anthony avenue. One wire on Rondo street tracks and one on fire hydrants. Along Rondo and Victoria street, running west on Rondo street to Victoria from end of line but a trace at intervals was found of pipe positive, and in no instance more than 0.8 volt; but running north on Victoria to St. Anthony avenue and connecting upon the same hydrant that, measuring from University avenue line, gave pipe positive 10.8 volts, gives from the Rondo street line rail positive 4 volts. From this it is apparent that the current from the Rondo tracks is flowing into the University avenue line by means of water mains.

One wire on Selby avenue tracks and one on fire hydrants, running both north and south on Victoria street. The wire was not long enough to reach from track to track of the parallel street car lines on Selby and Rondo and Grand, and also it is not practicable to lay it on the ground for long distances, as it is subject to being cut. Therefore all that could be determined was that the water pipe was charged for a distance of a quarter of a mile from each track. The average reading rail positive was about 8 volts and in duration extended over about nine-tenths of the time observed. Readings of 2 volts, pipe positive, extending over a limited period of time were observed. One wire on Grand avenue line and one on hydrant corner Victoria street and Lincoln avenue gave a reading of 12 volts, rail positive. Reference will be had to the map for further information.

Dale Street, from Front Street to Lincoln Avenue.—Date, Aug. 20 and Sept. 4, 1901; dry, clear and hot. One wire on Como Interurban track and one on hydrants. On August 21st, between 9 and 11 o'clock a. m., under ordinary conditions of traffic, voltmeter reads both pipe and rail positive. Rail positive averaging from 0. to 4 volts, extending over about one-third of the time observed. Pipe positive reads on an average 0. to 2.4 volts, extending over about two-thirds of the time observed. The bridge over the Great Northern Railway tracks and the gas main show no difference in potential. On September 4th, from same location, at 3 o'clock p. m., under stress of Fair traffic, all readings are pipe positive at Dale and Front streets, 4.5 to 19.5 volts and ammeter

readings 23 to 51 ams, fusing the ends of the lamp cord used in the test.

On August 21st, between 10 and 12 o'clock a. m., with one wire on University avenue tracks and one on hydrant, voltmeter reads constantly an average of 16 volts, with pipe positive, both north and south from University avenue, and passing south to St. Anthony avenue the reading is 16 volts. On September 4th exactly the same conditions existed, supplemented by an ammeter reading of 2.8 ams, nearly constant.

On August 21st, between 1 and 2 o'clock p. m., with one wire on the Rondo track and one on hydrants, voltmeter reads an average of 8.5 volts, with rail positive, closing up on St. Anthony avenue with 7.2 volts, rail positive. This is the same hydrant, when connected with the University avenue line, that gave a reading of 16 volts, pipe positive. No readings taken on Sept. 4, 1901.

Readings taken on all the hydrants, both from Selby avenue tracks and from Grand avenue tracks, gave essentially the same readings for their entire length as is shown upon readings from Dale street for the respective lines. Reference will be had to map.

Western Avenue, from Como Avenue to Seventh Street.—Date, Aug. 22, 1901; cool and very dry. One wire on Como Interurban track and one wire on hydrants. Running south to Blair street, voltmeter gives average readings of from 0. to 1.8 volts, rail positive, and of from 0. to 1.8 volts, pipe positive, each being of nearly equal duration. Running south to St. Anthony avenue, with one wire on University avenue track and one wire on hydrants, voltmeter gives constant readings of about 8 volts, pipe positive, closing on St. Anthony avenue with 9 volts. Running north to St. Anthony avenue, with one wire on Rondo street track and one wire on hydrants, voltmeter gives constant readings of 11 volts, with rail positive. This is the same hydrant that gave readings of 9 volts, pipe positive from Interurban track.

Running south to Marshall avenue from Rondo street track, voltmeter reads from 0. to 6.4 volts, rail positive and from 0. to 0.4 volt, pipe positive, and the rest of the hydrants showed no trace of pipe positive and gave average readings of 9.5 volts, rail positive.

Running north to Marshall avenue from Selby avenue tracks, voltmeter reads from 0. to 4.0 volts, rail positive, and from 0. to 2.0 pipe positive, each reading of equal duration. This is the same hydrant

that gave 0. to 6.4 volts, rail positive, when connected from Rondo street line. Connections made to hydrants on Western avenue from Grand avenue lines and Seventh street line give voltmeter readings of rail positive generally about 4 volts, and slight traces at intervals of pipe positive.

Aurora Avenue and Fuller Street.—Both streets parallel to University street car line, Aug. 29, 1901; dry and warm. Connections were made between hydrants on Aurora avenue and on Fuller street to Interurban tracks upon University avenue, commencing at Kent street and ending at St. Peter street. From Kent street to Marion street there is no pavement, and readings of voltmeters averaged about 7.0 volts, with pipe positive, and no indication of rail positive. Upon Rice and St. Peter streets, both paved, the voltmeter read about 2.0 volts, pipe positive, and no indication of negative.

Ninth street from Wabasha to Jackson, and on Tenth street from Jackson street to Broadway. Date, August 30th; dry and warm. These two streets are parallel to Seventh street, at right angles to Broadway, Jackson and Wabasha streets.

On Ninth street, from Wabasha street to Robert street, readings from Wabasha street tracks. On hydrants at Cedar, Minnesota and Robert streets, voltmeter read 1.8, pipe positive. On Ninth street, from Jackson to Robert streets, readings from Jackson street track, voltmeter reads on an average, pipe positive, 0. to 1. volt, rail positive from 0. to 0.8 volt upon same hydrants. All of these hydrants were read each way from Wabasha and from Jackson streets. See map.

On Tenth street, from Jackson street to Broadway, readings from Jackson street tracks. Readings upon all hydrants from 0. to 2.0 pipe positive, and when reading from Broadway rail, all readings were rail positive and about of the same intensity.

Agate street, which is parallel to Cortland street, upon the Jackson street car line. Readings from Jackson street line. Commencing at Cook and ending at Cayuga street, voltmeter reads rail positive, average of 8.5 volts, no indication of pipe positive. Reading from Mississippi track, voltmeter reads from 0. to 6. volts, rail positive, and from 0. to 1.4 volts, pipe positive. It seems that the current leaves the Mississippi street rails and passes through the medium of the water pipes to the Jackson street rails.

Readings were taken upon ten of the steam fire engine heaters which are connected with water mains, with the following result:

Engine No.	Location.	Connection Made with What Tracks.	Volts Pipe Positive	Volts Rail Positive	Amperes.
1	Ninth and Fort.....	Seven Corners..	0. to 3.0	.....	0.2
2	Wacouta and Seventh....	West Seventh..	.....	0. to 1.0	0.05
3	Ramsey and Leech.....	Ramsey.....	0. to 2.0	0. to 1.0	0.2
4	Tenth and Broadway. ..	Broadway and Tenth.....	.....	0. to 1.8	0.2
5	Mackubin and Selby.....	Selby.....	0. to 3.1	0. to 3.8	0.4
6	Delos and Clinton.....	Robert.....	0. to 4.0	.....	0.8
8	Eighth and Minnesota....	Eighth.....	.....	0. to 1.0	0.2
9	Marion and Edmund.....	University.....	.....	0. to 2.8	0.4
0	Randolph and Bay.....	East Seventh...	0. to 6.4	.....	1.5
2	Rosabel and Fifth.....	Fifth.....	0. to 0.8	0. to 0.8	0.6

From the above table it will be seen that many of the fire engines carry a current which is positive to the rail, and the firemen at these points state that they have trouble with their heater connections from the city water mains.

After all surveys had been made and readings platted the map was scanned to determine the points at which electrolytic action had probably taken place; these determined points were excavated to the bottom of water pipe, pipe was examined, samples of earth taken and scrapings were secured and photographs taken.

EXCAVATIONS.

Corner Dale and Rondo Streets, North of Car Line on Dale Street.—Date, June 18, 1901. Size of pipe, 16 inches. Laid July 1, 1888. Voltmeter, 0.1 to 7.2 volts, rail positive, and trace only of pipe positive. Soil sandy loam, slightly moist around the pipe. The pipe is slightly rusted in spots, but no decidedly perceptible electrolytic action has taken place; in fact, no such condition is to be expected, as rail is positive to the pipe. No photographs nor samples taken.

Northwest Corner of Dale Street and University Avenue.—Date, June 18, 1901. Size of pipe, 24 inches. Laid Aug. 14, 1888. Voltmeter reads from 6.2 to 12.2 volts, pipe positive. Soil, dry drift sand. Photograph taken marked No. 5. Surface of this pipe shows iron incrustation only in occasional spots, asphaltum paint apparently intact. This, however, is no indication that electrolytic action has not taken place, as samples now recently taken show that a large percentage of the iron has been removed from the pipe, and carbon has been deposited in its place without affecting the appearance of the asphaltum. No samples were taken, as chemical tests had not been decided upon at this time.

Dale Street, Near University Avenue.—Opposite rotary transformers of the Twin City Rapid Transit Company. Date, June 19, 1901. Size of pipe, 16 inches. Laid July 31, 1888. Voltmeter reads from 6.3 to 12.1 volts, pipe positive. No trace of rail positive. Soil, dry drift sand. Photographs taken marked No. 1. No samples taken. Exactly the same condition exists at this point as existed at northwest corner of Dale and University. Two-inch lead pipe connecting 16-inch water main with transformer at station shows decided electrolytic action. This lead pipe disconnected at union and with ammeter put into circuit gave reading of 4.1 amperes.

Eagle and Washington Streets, at Intersection of Pipe Lines.—Date, June 24, 1901. Size of pipe, 4 inches by 6 inches, cross. Laid May 22, 1889. This excavation was made near the Eagle street power house of the Twin City Rapid Transit Company; connection was made between the street car tracks upon Fourth and Washington streets and the water main at point designated. Voltmeter reads 0. to 2.0 volts, pipe positive between tracks and pipe; trace of pipe positive between gas lamp post and pipe; trace of pipe positive between pipe and ground. Depth of water pipe, 7 feet. Character of soil, sandy loam, mixed with fragments of stone. Moist. The cross and the pipe leading therefrom are thoroughly coated with iron incrustation, and are deeply pitted. Surrounding soil, pebbles and stone to a distance of 18 inches surrounding pipe are impregnated or coated with iron rust. I refer to chemical analysis of Professor Weitbrecht, samples being taken from earth and from scale around pipe. Photograph taken marked No. 2. As a matter of information, connections made between rail and hydrant at Seven Corners give essentially the same results.

Summit Avenue, Between Cedar and Wabasha Streets.—Date, June 26, 1901. Size of pipe, 6 inches. Laid in 1885. Repaired in 1899. Reference is had to photograph No. 18. Voltmeter connected between tracks on Wabasha street, and pipe reads 2.1 volts, pipe positive. Pipe lies in water, and is covered to a depth of nearly a foot above the top of the pipe. Soil, clay and sand mixed. Pipe apparently sound.

Eighth Street, Between Cedar and Minnesota Streets.—Date, June 25, 1901. Size of pipe, 4 inches; removed and replaced with 8-inch pipe. Laid originally in 1883. Connection was made between street car rail on Eighth street, and the 4-inch pipe giving a reading of pipe positive 1.0 volt. The Eighth street line of rail forms a portion of the St. Paul loop line, and most of the street cars pass over it. Samples were taken of surrounding soil, soil near the surface of the ground, and of scale surrounding the pipe. The most of this pipe was in very poor condition, covered with iron incrustation, caused by electrolytic action. From the condition set forth it is plainly perceptible that electrolytic action has taken place. Reference is had to tabulation No. 1, report of Professor Weitbrecht, samples Nos. 5 and 6; photographs taken marked No. 3.

Pleasant Avenue in Front of the People's Church.—Date, June 28, 1901. Size of pipe, 6 inches. Laid originally in 1884, repaired in 1898. Point at which excavation is made is where pipe was repaired and both old and new pipe was exposed, together with lead service pipe which was cut off, all of which is shown in photograph No. 4. Both the new and the old pipe were encased in a scale of iron oxide of a thickness on an average of 7-16-inch, which, under a light blow struck by the file, separated from the pipe and fell away, forming a perfect mold of the water pipe. From the chemical analysis it will be seen that the pipe has parted with a portion of its iron and carbon has taken its place, thus causing the pipe to deteriorate. There are no chemical compounds in the soil which would cause this condition unaided by an electric current which passed *from* the pipe, designated in the report as "pipe positive." No scrapings under asphaltum were taken from this pipe.

Main, East Seventh and Phalen Avenue.—Date, July 15, 1901. Size, 16 inches. Laid in August, 1890. Connection between rail on East Seventh street and water main, giving a reading of rail

positive 5.2 volts and of pipe positive 1.7 volts, each of about equal duration and high reading of rail positive observed when car was starting up after a stop for passengers. Depth of pipe, 7 feet below surface of ground. Soil, sand and gravel mixed, with very little moisture present. Photograph taken, No. 6. A sample of the soil surrounding and distant from the pipe about 2 feet, numbered 11. The general appearance of the pipe would indicate electrolytic action in a slight degree, though were there more moisture present in the soil, it might be more pronounced. This excavation is located on the Wildwood and Stillwater line.

Main, East Seventh and Ross Streets.—Date, July 16, 1901. Size, 16 inches. Laid October, 1885. Connection between rail and water main, giving a reading of rail positive 3 volts and of pipe positive 4.6 volts, each of about equal duration and high reading of rail positive observed when car was starting up after a stop for passengers. Depth of pipe, 7 feet below surface of ground. Soil, very dry drift sand. Sample taken 18 inches from pipe, marked No. 12. Photograph taken marked No. 7. The general appearance of this pipe would indicate electrolytic action in a more marked degree than was indicated at Phalen street.

Main, South Wabasha and Delos Streets.—Date, July 17, 1901. Size, 6 inches, cross. Laid October, 1887. Connection between rail and water main, giving readings of rail positive 0. to 2 volts and pipe positive 0. to 4.4 volts, pipe positive being of greatest duration. Depth of pipe, about 6 feet below surface of ground. Soil, sandy clay, moist to the surface of ground. Photograph taken marked No. 8. Four samples taken, numbered 13 to 16 inclusive. This cross was covered with a scale of rust, which readily broke away from water main under slight taps of a file, presenting the appearance of a cast. Under the scale in many places the asphaltum was perfectly fresh and uninjured, but at others rust had destroyed asphaltum and had eaten into pipe. After carefully removing the asphaltum a dull, blackish powder was found, resembling graphite. The entire pipe exposed presented many "pittings," all of them being filled with above-described substance. Reference being had to tabulation, sample No. 13, it will be seen that substance found contained a very large percentage of carbon. At points it was very easy to actually shave the pipe with an ordinary pocket knife.

It is of interest to note that, when survey of line was made when temperature was 10 degrees below zero, that reading upon nearest hydrant gave a maximum reading of pipe positive 7 volts. Electrolytic action very pronounced.

Main, South Robert and Wood Streets.—Date, July 18, 1901. Size, 6 inches. Laid May, 1888. Connection between rail and water main, giving reading of 0. to 8 volts, rail positive and 0. to 2 volts, pipe positive, each of about equal duration. Depth of pipe, about 7 feet below surface of ground. Soil, sand, gravel and stones mixed. Dry. Photograph taken marked No. 9. Two samples taken, numbered 17 and 18. Pipe thoroughly incrusted with scale, which, being broken off, permitted pipe to be cut as described in previous article. Electrolytic action very pronounced.

Main, Mississippi Street and Pennsylvania Avenue.—Date, July 22, 1901. Size, 30 inches. Laid 1884. Connection between rail and water main, giving readings of 0. to 4 volts, rail positive and 0. to 1 volt, pipe positive, the latter being of the longest duration. Depth of pipe, about 4 feet from top of pipe to surface of ground. Slightly moist, sandy soil. Photograph taken marked No. 10. Three samples taken, numbered 19 to 21, inclusive. Pipe badly spotted with rust and under rust carbon easily removed by shaving with knife. Soil shows trace of iron deposited upon stones and gravel surrounding pipe.

Main, Jackson and Valley Streets.—Date, July 23, 1901. Size, 16 inches. Laid September, 1887. Connection between rail and water main, giving readings of rail positive 0. to 5.0 volts and of pipe positive 0. to 1.7 volts, pipe positive being of greater duration. Depth of pipe, about 7 feet below surface of the ground. Soil, slightly moist sand. Photograph taken marked No. 11. Three samples taken, numbered 22 to 24, inclusive. Spots and patches of rust appear upon the pipe, which, when removed, show the asphaltum uninjured, but upon removing asphaltum, carbon appeared upon surface and pipe underneath was susceptible of being cut with a pocket knife.

Main, Jackson and Twelfth Streets.—Date, July 23, 1901. Size, 16 inches. Laid May, 1885. Connection between rail and water main, giving readings of rail positive 0. to 4.0 volts and of pipe positive 0. to 1.2 volts, duration of rail positive being very short and only noticeable when car was near. Depth from surface of ground

Main Upon Walnut Street, Near South Line of Seventh Street.—Date, Aug. 24, 1901. Size, 4 inches. Laid prior to 1882. Connection between street car rail and water main on Walnut street, giving rail positive 0. to 1.7 volts, and pipe positive 0. to 0.8 volt. The street car rails upon Seventh street have been relaid this year with welded joints resting upon concrete foundation, but upon Feb. 8, 1901, at which time old track with imperfectly bonded joints was in place, readings between rail and hydrant at the corner were from 2.9 to 8 volts, pipe positive, and at the present time between hydrant and rail are essentially as given above for pipe. Difference in potential between gas lamp post and rail range about 0.3 volt higher than for water main. Difference in potential between earth and pipe 0.2 volt. Photograph taken, marked No. 13, showing the 4-inch pipe and the valve box. Three samples taken, numbered from 30 to 32, inclusive. Soil, sandy loam, mixed with broken stone, moist at pipe, very dry near surface. Depth of pipe, 7 feet. The same general conditions exist as are noted upon pipe Tenth and Jackson streets.

Main Upon Selby Avenue at Nina Avenue.—Date, Aug. 26, 1901. Size, 6 inches. Laid 1884. Connection between street car rail and water main, giving voltmeter reading 1. to 2.1 volts, pipe positive, and ammeter reading of 1.2 ams. Connection between earth and pipe, 0.4 volt; between gas pipe and water main, gas main positive, 0.9 volt. Depth of pipe, 8.5 feet below surface of ground. Soil, gravelly, mixed with sand; slightly moist around pipe, but dry near surface. Photograph taken marked No. 15. Three samples taken, numbered 36 to 38, inclusive.

In excavating at this point a gas service of 1¼-inch wrought iron pipe was encountered almost entirely destroyed. The water main was entirely surrounded by a scale of iron oxide nearly one-half inch in thickness which, when broken off, presented a perfect mold of the pipe, leaving the asphaltum underneath as clean and bright as the day it was put in. This is well shown in the photograph. Underneath asphaltum the same carbon was found deposited in pittings as essentially as elsewhere described, and the pipe whittled readily to the pocket knife. This is a very pronounced case.

Main, Lexington and University Avenues.—Exposed at 12-inch by 20-inch cross. Date, Aug. 26, 1901. Laid October, 1888. Connection between street car rail on University avenue and water main

giving readings, voltmeter, 5.8 volts, pipe positive, ammeter, 1.8 amps. Voltmeter between pipe and ground, 0.2 volt; between rail and earth near pipe, 2.0 volts; between rail and trolley pole, 2. volts, pole positive. Depth of pipe, 6 feet. Soil, dry sand. Photograph taken marked No. 16. Three samples were taken, numbered 39 to 41, inclusive. The cross was well covered with spots of iron oxide, lead in joint showed lead carbonate, and in all other essentials this is the same as other cases noted herein.

Thirty-Six-Inch Low Pressure Main Upon Overton Avenue.—Date, Sept. 11, 1901. Two excavations were made, the first 1,000 feet and the second 2,000 feet north of Maryland avenue. Laid in 1884.

One Thousand Feet North of Maryland Avenue.—Connection between earth and pipe giving 0.2 volt, pipe positive. Depth of top of pipe, 2 feet below surface of ground. Soil for 2 feet below surface, moist sand; the remainder to bottom of main, clay and swamp bog. Photograph taken marked No. 17. Three samples taken, numbered 42 to 44, inclusive. Pipe showed spots of iron oxide, and underlying the asphaltum, carbon. No serious damage done.

Two Thousand Feet North of Maryland Avenue.—Connections between earth and main shows the barely perceptible trace of current. Depth to top of pipe, 5 feet. No photograph taken on account of rain. Two samples taken, numbered 45 and 46. Soil, stiff wet clay. This pipe was perfectly bright and clean, barest traces of iron oxide, lead joint clean and no trace of carbonate. Scraped off asphalt and found no traces of carbon underneath. Pipe could not be shaved with knife.

Twenty-Four-Inch High Pressure Service Main, Laid in 1883, Upon Dale Street.—Date, Sept. 13, 1901. Excavation made at a point about 300 feet south of where road to reservoir leaves Dale street. No trace of electrical current between earth and main. Soil, sandy, slightly moist around main. Photograph taken marked No. 23. Depth of pipe, about 8 feet to top of pipe. Samples taken, numbered 47 and 48. This pipe perfectly bright and clean, barest traces of iron oxide, lead joint clean and no trace of lead carbonate. Scraped off asphalt and found that iron could not be shaved with knife. No indication of carbon under asphaltum. This point outside of city limits not marked on map.

Twenty-Four-Inch Main Upon University Avenue, About 80 Feet East of St. Albans Street, Exposing 5/8-Inch Lead Service, to No. 665 University Avenue.—Date, Sept. 18, 1901. Laid Oct. 15, 1888. Connection between street car rail and water main giving the following readings: Upon the voltmeter, 12. to 14.7 volts, pipe positive, and upon the ammeter, 25 to 41 ams. Between earth and pipe, 0.7 volt, pipe positive. Soil, dry sand. Depth of pipe, 5 feet to top of pipe. Photograph taken marked No. 24. Four samples taken, numbered 49 to 52, inclusive.

This main in very bad condition. Large scales of iron oxide upon it, and surrounding pebbles coated with iron oxide. Asphaltum generally clean, but underneath heavy coating of carbon. Pipe easily shaved with knife. Photograph shows 5/8-inch lead service, which is badly coated with carbonate of lead. Brass corporation cock badly corroded. Altogether, in making examinations, great care had to be used to avoid injuring service pipe. Analyses show nothing in the soil which could cause such conditions to exist, and, as before stated, the soil is dry sand.

Lead Service to 2504 University Avenue.—Date, Sept. 18, 1901. Connection between street car rail and lead service gives the following readings: Voltmeter, 0. to 2.7 volts, rail positive, and 0. to 3.3, pipe positive, the latter being of longest duration. Connection between two severed ends of service pipe give voltmeter 1.1 volts, and ammeter 1.5 ams; between earth and pipe, voltmeter 0.4 volt. Pipe badly pitted and covered with lead carbonate. No photograph and no samples taken. Soil, sandy loam, quite moist, this being accounted for by reason of the bursted pipe.

Photograph No. 18 shows a 1½-inch wrought iron service taken from Hill street. It is introduced only to show the action of an electric current upon the wrought iron, and was taken from ground about one and one-half years ago.

Photograph No. 19 shows a series of service pipes which had to be replaced by reason of bursts. In every instance these lead pipes were coated with lead carbonate, which, according to Professor Weitbrecht, could occur only by reason of an electrical current passing from them.

No. 1 was lead service, from main to drinking fountain at Sixth street and Broadway, originally laid October, 1895. Removed and

replaced with new service May 3, 1901, at a point 40 feet from Broadway line of cars.

No. 2 was lead service, from main to No. 2231 Tainter avenue, originally laid August, 1891. Removed and replaced with new service April 4, 1901. Location of this pipe, four blocks from car line.

Nos. 3 and 6 was lead service, from main to No. 740 Pleasant avenue, originally laid in 1890. Removed and replaced with new service 1897.

No. 4 was lead service, from main to No. 1680 Capitol avenue, originally laid September, 1891. Removed and replaced with new service June 1, 1901.

No. 5 was lead service, from main to No. 365 Jackson street, originally laid April, 1881. Removed and replaced with new service October, 1899.

No. 7 was lead service, from main to No. 245 West Seventh street, originally laid April, 1875. Removed and replaced with new service December, 1899.

No. 8 was lead service, from main to No. 473 Jackson street, originally laid September, 1883. Removed and replaced with new service May 9, 1901. The sample shown of the pipe removed came from directly under the rails of the street car tracks.

No. 9 was lead service, from main to No. 20 East Eighth street, originally laid June 1, 1895. Removed and replaced with new service May 11, 1901. This also came from under street car tracks.

No. 10 was lead service, from main to No. 622 Rondo street, originally laid October, 1888. Removed and replaced with new service July, 1900.

Nos. 11 and 12 were two curb cocks, laid within 18 inches of each other upon East Fifth street, east of Cedar street. A wire was connected to them—presumably from the lightning arrester located upon an iron pole belonging to the Street Railway Company. Leaks were developed, and upon digging down the workmen received an electrical shock whilst disconnecting wire. The wires have been removed. Cocks removed October, 1900.

No. 13 was wrought iron service, laid July, 1890, to No. 740 Pleasant avenue. Removed May 14, 1901.

All of these samples have been taken from widely divergent portions of the city and represent but a very small percentage of

"bursts" which have been repaired. It is of interest to note that, though the examples are widely diffused, they all come within the area designated as dangerous by red figures upon the map.

Many instances of pipe failure have been reported by plumbers, which they ascribed to "something in the soil eating up the pipes," and they were right; but, by reference to Professor Weitbrecht's analyses, this "something" was not chemical.

Photographs No. 20 and No. 21.—Lead service pipes which were removed from the Court House and City Hall. For the past two years there has been constant complaint of failure of service pipes within the grounds and in the Court House and City Hall. In every instance where the pipe laid outside of the building the failure has been attributed to carelessness upon the part of the employes, by reason of their having permitted water to freeze and burst the pipes, but this is proved to be incorrect.

Nos. 1, 2 and 3 were taken from under the basement of the building in the winter of 1900, having been placed in position when the building was erected.

Connection between Fourth street rail and the pipes gave readings of 1.8 volts, pipe positive.

No. 4 is from the sprinkler service upon the Fourth street side of the building. In the spring of 1899 the section between points A and C was put in to replace a burst in the pipe. In the spring of 1901 the lead joint marked B was wiped onto the pipe to repair a small leak, and, finally, a few days prior to July 10, 1901, another leak was developed about midway between A and B, and the piece of pipe shown had to be removed. Reading of ammeter between cut ends gives 0.5 ams. The entire lawn sprinkling system is closed off each winter and the pipes drained, so bursts cannot be attributed to freezing, added to which, note that last burst occurred in July, between two and three months after lawn sprinkling commenced, and that the pipe had been laid only two years previously.

Photograph No. 22 speaks for itself, and all that has been written regarding lead service in front of No. 665 University avenue, near St. Albans street, will apply to it.

In conclusion, I beg to call to your attention that the excavations made fully justified the assumption of probable electrolytic action at the points assumed, and by inspection of the map it will

be found that the danger area is very large, much of it being in the heart of the city, jeopardizing much property in case of a failure of water supply during a conflagration.

Respectfully submitted,

O. CLAUSSEN,
City Engineer.

CHEMICAL ANALYSES

AND

REPORT THEREON

ACCOMPANYING

EPORT UPON ELECTROLYSIS

WITHIN

THE CITY OF ST. PAUL

MINNESOTA.

1901.

REPORT ON CHEMICAL ANALYSES.

Mr. Oscar Claussen, City Engineer:

From time to time, from June 28th to August 26th of this year, I have received from the bridge engineer, Mr. Edmondstone, samples of earthy matter taken from and near the city water mains. These samples were marked: "From Pipe," "Surrounding Earth," "Scrapings from under Asphaltum." There were forty-one (41) samples in all. Besides these, five samples remote from the water mains, but characteristic samples of the sands of this vicinity, were collected by myself. All these samples were subject to analysis to determine their chemical composition. Attached is tabulation 1, showing the sources of the samples collected by Mr. Edmondstone, together with the analysis of each.

Tabulation 2 consists of all the samples of tabulation 1 that were marked "From Pipe."

Tabulation 3 consists of all samples of No. 1 that were marked "Surrounding Earth."

Tabulation 4 consists of all samples of No. 1 that were marked "Scrapings from under Asphaltum."

Tabulation 5 consists of the five samples collected from sources remote from water mains.

The samples "From Pipe" were uniformly colored with iron stain. This iron stain is usually called oxide of iron; more properly speaking, it is hydrated oxide and carbonate of iron. The iron compounds in each case were very soluble in dilute hydrochloric acid. The insoluble material consisted of silica or sand similar in color and appearance to the ordinary drift sand that is spread over the surface of the city of St. Paul. These samples consisted of a scale-like formation of sand and carbonate of iron, forming a sort of an iron cement about the pipe. In some instances it was half an inch thick. This matter I shall allude to below in connection with the matter of the "Scrapings from under Asphaltum" and electrical action.

TABULATION 1—Continued.

Number.		Moisture.	Silica and Insoluble Matter.	Iron Oxide.	Aluminum Oxide.	Calcium and Magnesium Carbonate.	Lead Carbonate.	Remarks.
21	Surrounding earth, Mississippi and Pennsylvania.	1.2	93.6	5.2	.....	1.0	.....	
22	Scrapings under asphaltum, Jackson and Valley streets.....	3.35	70.	26.9	.....	.....	.....	Residue largely carbon
23	From pipe, Jackson and Valley streets	2.0	84.2	13.2	.....	.....	.....	
24	Surrounding earth, Jackson and Valley streets.....	3.1	93.3	3.1	.....	.....	.....	
25	From pipe, Jackson and Twelfth streets.....	5.4	65.3	22.5	.....	7.0	.....	
26	Surrounding earth, Jackson and Twelfth streets....	3.6	64.5	11.5	.....	20.6	.....	
27	Scrapings under asphaltum, Jackson and Twelfth streets	4.5	75.4	19.6	.....	.....	.....	Residue largely carbon
28	Surrounding earth 150 feet north from Jackson on Tenth street.....	5.3	87.3	6.4	.....	.7	.....	
29	Earth adjacent to pipe 150 feet north from Jackson on Tenth street.....	2.3	88.5	6.4	.....	2.6	.....	
30	Surrounding earth, Seventh and Walnut streets.....	1.7	48.3	9.8	1.7	38.0	.....	
31	From pipe, Seventh and Walnut streets.....	3.1	48.0	28.7	0.7	19.6	.....	
32	Scrapings under asphaltum, Seventh and Walnut streets.....	7.84	13.72	78.43	.....	.....	.....	Residue largely carbon
33	Surrounding earth, Jackson and Tenth streets.....	3.1	68.8	20.1	1.3	6.8	.....	
34	From pipe, Jackson and Tenth streets.....	2.4	88.9	8.1	.....	.....	.....	
35	Scrapings under asphaltum, Jackson and Tenth streets	.0	44.44	55.55	.....	.....	.....	Residue largely carbon
36	Surrounding earth, Selby and Nina.....	5.7	89.5	3.6	.....	0.7	.....	
37	From pipe, Selby and Nina	1.7	88.2	9.6	.....	trace	.....	
38	Scrapings under asphaltum, Selby and Nina....	4.6	39.0	56.4	.....	.....	.....	Residue largely carbon
39	Surrounding earth, University and Lexington..	2.0	93.6	4.3	.....	trace	.....	
40	From pipe, University and Lexington.....	1.5	88.7	9.5	.....	1.0	.....	
41	Scrapings under asphaltum, Lexington and University.....	5.66	62.26	32.08	.....	.....	.....	Residue largely carbon

TABULATION 2.

Grouping of Samples from Tabulation Marked "From Pipe" Showing the Amount of Iron and Lead in Each.

Number.		Iron Oxide.	Lead Carbonate	Magnesium and Calcium Carbonate.
1	Eagle and Washington	28.5		
2	Eagle and Hill	18.2		3.6
3	Front of People's Church	22.0		3.2
4	Between Cedar and Minnesota on Eighth	16.5		9.
7	Court House yard	0.55	83.7	
9	Dale Street, opposite power station.	8.2		trace
12	Seventh and Ross	13.5		
15	South Wabasha and Delos	4.5		
16	South Wabasha and Delos	17.8		
17	South Robert and Wood	7.5		
19	Mississippi and Pennsylvania	12.6		0.5
23	Jackson and Valley	13.2		
25	Jackson and Twelfth	22.5		7.
31	Seventh and Walnut	28.7		19.6
34	Jackson and Tenth	8.1		
37	Selby and Nina	9.6		trace
40	University and Lexington	9.5		1.0

TABULATION 3.

Grouping of Samples From Tabulation Marked "Surrounding Earth," Showing Amount of Iron Oxide in Each.

Number.		Iron Oxide.	Aluminum Oxide.	Magnesia and Calcium Carbonates.
4	In front of People's Church	4.5		6.8
5	Cedar and Minnesota, on Eighth	2.5		6.
8	Court House yard	15.5	9.5	
10	Dale street, opposite power station.	1.2		8.1
11	Seventh and Phalen	5.3		
14	South Wabasha and Delos streets.	4.1		
18	South Robert and Wood streets	2.8		6.
21	Mississippi street and Pennsylvania avenue	5.2		1.0
24	Jackson and Valley streets	3.1		
26	Jackson and Twelfth streets	11.5		20.6
28	150 feet north of Jackson on Tenth	6.4		.7
30	Seventh and Walnut streets	9.8	1.7	38.
33	Jackson and Tenth streets	20.1	1.3	6.8
36	Selby and Nina	3.6		.7
39	University and Lexington	4.3		trace.

TABULATION 4.

Grouping of Samples From Tabulation Marked "Scrapings From Asphaltum," Showing Amount of Iron Oxide, &c.

Number.		Iron Oxide.	Silica and Insoluble Carbon.
13	South Wabasha and Delos streets	25.2	68.0
20	Mississippi street and Pennsylvania avenue	11.2	79.34
22	Jackson and Valley streets	26.9	70.
27	Jackson and Twelfth streets	19.6	75.4
32	Summit avenue and Walnut street	13.7	78.43
35	Jackson and Tenth streets	55.55	44.44
38	Selby and Nina avenues	56.4	39.
41	Lexington and University avenues	32.08	62.26

In all the samples of this table the silica and insoluble matter consisted largely of carbon.

TABULATION 5.

Sands From Sources Remote From Water Mains.

	Moisture.	Silica and Insoluble Matter.	Iron Oxide.
New sewer, Central avenue, near Victoria street	2.5	9.6	1.1
New sewer, Central avenue, near Nash, from T. C. R. T. Co.'s gravel pit on Mississippi street line	2.7	95.4	0.6
From Curtis stone yard	2.0	97.1	0.8
New sewer, new market house	5.2	94.	0.4
Bank, Park and University avenues	0.0	99.1	0.4

TABULATION.

Number.		Moisture.	Silica and Insoluble Matter.	Iron Oxide.	Aluminum.	Calcium Magnesia Carbonate.
	FROM PIPE.					
42	1,000 feet north of Maryland street.....	4.1	90.7	3.7	0.7	0.4
45	2,000 feet north of Maryland street.....	5.5	86.0	7.3	5.0	2.0
47	300 feet south from Reservoir road in Dale street immediately surrounding pipe.....	1.7	95.0	3.1	0.0	trace.
	SURROUNDING EARTH.					
43	1,000 feet north of Maryland street.....	.7	95.6	2.5	6.5	0.4
46	2,000 feet north of Maryland street.....	6.6	88.5	4.0	.5	trace.
48	Dale street 300 feet south from Reservoir road, 18 inches from pipe...	1.4	97.7	0.6	.0	trace.
	SCRAPINGS UNDER ASPHALTUM.					
44	1,000 feet north of Maryland street.....	6.0	52.5	40.0	largely carbon	

The notes coming with the above samples gave the voltage in Nos. 42, 43 and 44 as..... .2 volts.
Nos. 45 and 46 as..... .3 volts.
Nos. 47 and 48 as..... .0 votls.

A comparison of the percentum of iron oxide in these samples as compared with those in tabulation 2 and 3 is very significant. In tabulation 2 "From Pipe" the iron compounds were very high, while in these samples from pipe they are low, with the exception of the sample taken from under asphalt, when the iron compound is 40 per cent. Again, in samples 47 and 48, taken from pipe and surrounding earth, when there was no voltage the iron compounds are still lower. That of No. 47 shows more than the average amount of iron in the vicinity, while that of 48 is normal sand.

No. 47 shows that at some time there has been a slight amount of current escaping. Probably this occurred at some season of the year when the soils in the vicinity of the pipe were very dry.

The following is the analysis of the free samples from in front of residence No. 665 University avenue, near St. Albans street:

Number.		Moisture.	Silica and insoluble Matter.	Iron Oxide.	Alumina.	Lead Caobonate.	Magnesia and Calcium Carbonate.
49	From pipe.....	0.3	94.3	4.9	0.3	.....	trace
50	Surrounding earth.....	0.8	94.7	3.9	0.4	.....	trace
51	Under asphaltum.....	21.9	63.12	14.7	.....	.....	.....
52	Lead carbonate.....	1.23	13.68	7.42	.....	77.42	.....

In sample No. 52, under the head of Silica and Insoluble Matter, there was 6.19 per cent of lead metal.

In sample No. 51, under the head of Silica and Insoluble Matter, there was a small amount of carbon. The great mass of insoluble matter consisted of silica.

Comparison of new lead service pipe taken from water department's stock and old service pipe taken out of earth.

In making this comparison three samples of each were taken. These samples were slightly over an inch in length. They were made as near a uniform length as a skilled mechanic could make them with micrometer and tools. Nos. 1, 2 and 3 are samples of new pipe. Nos. 4, 5 and 6, samples of the old pipe. The following are the weights and volume and specific gravities of the new pipes:

No.	Weight in Grains.	Volume in Cubic Centimeters.	Specific Gravity.
1	133.735	11.748	11.383
2	133.496	11.729	11.381
3	134.871	11.854	11.386
4	114.582	.....	.....
5	118.200	.....	.....
6	116.175	.....	.....

There is, as expected, a slight error in the volume. No. 2 is .019 cubic centimeters less than No. 1. No. 3 is .106 cubic centimeters more than No. 1.

A comparison of Nos. 4, 5 and 6 with Nos. 1, 2 and 3, shows a great loss of weight. The average weight of the samples Nos. 1, 2 and 3 is.....134.034 grains
The average of 4, 5 and 6 is.....116.319 grains

The loss of Weight is..... 17.715 grains or 13.2 %.

There still were particles of lead carbonate adhering to the samples 4, 5 and 6, which would slightly increase the difference in weight were they to be removed; however, not materially.

Respectfully submitted,

GEORGE WEITBRECHT.

From record of board meeting Dec. 11, 1901:

"A report was received from A. J. Stobbart, assistant corporation attorney, on the report of the city engineer on the electrical survey and examination of the water mains and pipes of this city. Report was received and placed on file, and the secretary directed to send a formal demand to the St. Paul City Railway Company, directing said company to take proper steps looking to the adoption of some new system or to change the existing one under which cars are operated, so as to prevent any further damage to the water supply system of St. Paul." * * *

LAW DEPARTMENT.

ST. PAUL, MINN., Dec. 9, 1901.

To the Board of Water Commissioners,

GENTLEMEN: I have yours of the 12th ultimo, transmitting the report of City Engineer Claussen upon the electrical survey and examination of the water mains and pipes of the city, conducted by him at the request of your board for the purpose of ascertaining the extent to which said water supply system has been and is now being affected by the action of electrolysis, caused by

escaping street railway currents, said reports being accompanied by some twenty-six photographs and map showing results of said survey and a report from Professor Weitbrecht showing results of a chemical analysis made by him in connection with said investigation.

I am requested by said communication to advise as to the proper action to be taken by your board in order that further damage to the water system may be prevented.

The report embraces the results of an electrical survey by voltmeter measurement tests of the water mains and pipes along about forty-three miles of double and fifteen miles of single track operated by the street railway company, and also along a number of streets running parallel and at right angles to the different street railway lines and also upon the actual physical condition of the water pipes disclosed by excavations, and of a chemical analysis of the pipe so uncovered and of the earth surrounding said pipes.

The report establishes beyond a doubt that electrolysis, or decay of water pipes from the effects of stray electric street railway current exists in all parts of the city of St. Paul and is not confined to the mains and pipes located in streets over which the lines of the railway company are operated; that at every point where an excavation for inspection of mains and pipes was made the characteristics of electrolysis were shown to exist, and while the mains do not show evidence of serious injury the various tests demonstrated conclusively that accumulative damage is caused to the system, and at points it was very easy to actually shave the pipe with an ordinary pocket knife.

Mr. Claussen suggests that the only remedy which can be adopted to overcome this serious menace to a full and proper water supply is to compel the adoption by the street railway company of a complete metallic circuit, insulated from the rails and ground, providing a conductor for the return of the current to the substation rotary transformer as perfect as the conductor that is provided to supply the energy along the railway lines for driving the motors, and that this can be done by the adoption of the so-called underground circuit system or the double trolley system.

As a means of temporary relief he suggests that the railway company be required to maintain its tracks in a first-class condition by putting in large rails and welded joints, or by installing

and properly maintaining bonds of the same electrical carrying capacity as the rails. The report, however, indicates that no matter how well the rails were, by this examination, found to be bonded, there was a perceptible leakage resulting in electrolytic action.

As I stated to you in my communication of Nov. 19, 1900, a full and adequate supply of water is of greater importance to the inhabitants of this city than a street car service, and that if the present system under which the street railway is operated results in an injury to the city's water system so as to impair its efficiency, the railway company should be called upon to so change said system as to remove the cause of said injury.

I would therefore respectfully suggest that your board call upon the street railway company to so change its system as to eliminate any possibility of further injury to the city's water system, and that in case the said railway company fails within a reasonable time to so change its system, proceedings will be commenced against it to enforce the rights of your board.

I submit herewith a form of demand for your approval, and I return all papers handed me in connection with this matter.

Respectfully yours,

ARTHUR J. STOBBART,

Asst. Corporation Attorney.

ST. PAUL, MINN., Dec. 12, 1901.

The St. Paul City Railway Company, St. Paul, Minn.,

GENTLEMEN: The results of an electrical survey and examination of the water mains and pipes forming the supply system of the city of St. Paul, made under the direction of this board for the purpose of ascertaining to what extent said mains and pipes were affected by electrolytic action indicate conclusively that electrolysis or decay of water pipes from the effects of stray electric street railway currents exist in all parts of the water distribution system of the city of St. Paul, and that this leakage of current is

brought about by the system under which the various lines of street railway are operated by you in this city.

It is further represented to this board that the trouble complained of can be overcome only by the adoption of the so-called underground conduit or double trolley system, but that to some extent existing conditions may be improved by maintaining tracks in a first-class condition and by putting in large rails and welded joints, or by installing and properly maintaining bonds of the same electrical carrying capacity as the rails.

In view of the damage the water system has already sustained from this cause and of the greater damage it will undoubtedly sustain in the future in case the present system is continued in use by your company, the Board of Water Commissioners, at a meeting held on December 11th, instructed me to address a communication to you directing that your company take the proper steps looking to the adoption of some new system or to so change the existing one under which the cars are operated as to prevent any further damage to the water supply system of the city of St. Paul, and that in case your said company fails within a reasonable time so to adopt or change the system, in order that future damage may be prevented, legal proceedings will be commenced by this board for the enforcement of its rights and for the full and proper protection of the city's water supply.

I am also directed to further notify your said company that this board will hold your company liable for any and all damages sustained to the water system of the city of St. Paul by reason of stray electric street railway currents.

Respectfully yours,

JOHN CAULFIELD,
Secretary.

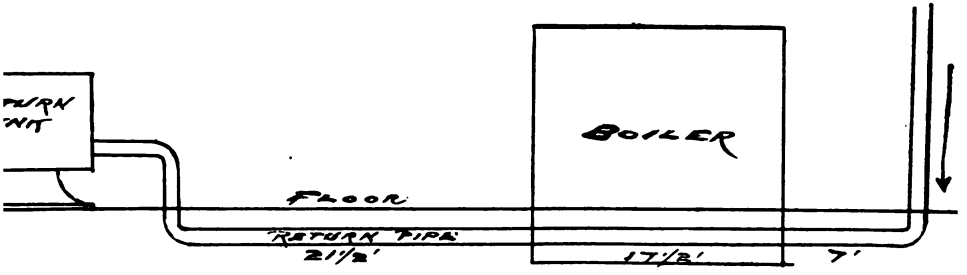
REPORT OF INJURY TO RETURN PIPE OF THE STEAM PLANT AT THE MECHANIC ARTS HIGH SCHOOL BY ELECTROLYSIS.

ST. PAUL, Minn., Nov. 18, 1901.

Hon. Bernard Zimmermann, President Board of School Inspectors,

DEAR SIR: On the morning of November 6th, the engineer of

this and the Madison building reported to me that the common return pipe of the two buildings had burst, and that the water was flooding the boiler room floor.



This return pipe is 46 feet long. It collects the condensation from the two buildings at the rear of the boiler, passing under the boiler to the return tank in front of the boiler. It is buried in the soil, save where it passes under the boiler. The 7 feet to the right of the boiler shows some degeneration. The 17½ feet under the boiler none; the 21½ feet to the left of the boiler, a great deal of degeneration. This portion of the pipe was covered with a scale varying from ⅛ inch to ¼ inch in thickness. The under surface was more affected than the top. At one place the metal was reduced to the thickness of a sheet of paper. At this point the pipe burst.

The incrustation surrounding the pipe consisted of carbonate of oxide of iron.

The appearance of the pipe indicated that it had been subject to electric currents. To determine this I had Mr. McClintock take measurements between the boiler plant and the Twin City Rapid Transit Company's tracks on Wabasha street. These measurements showed that there was a difference of 2-3 volts and 6-8 amperes of current with the plant + to the rail.

On Sunday, the 10th inst., at 4:30 a. m., Mr. McClintock made another test; this test showed an appreciable amount of voltage. As he was winding up the wire the early mail car passed down Wabasha street. The oncoming of this car was no doubt the cause of the small amount of voltage shown by the instrument.

On the 13th inst., an iron stake 6 feet long and 1 inch in diame-

ter, was driven into the earth in the building. The instruments put in circuit with this stake and the boiler plant showed deflections of the galvanometer needle and 1-10 volts by the voltmeter.

This experiment was to determine if the current that before was proven to be in the plant was passing off the plant into the ground. It was conclusive that such was the case. This current was simply a short current. How much was passing off through the "blow off" pipes, four in number, buried in moist earth and aggregating at least 100 feet in length, we could not determine without disconnecting the boiler plant from these "blow off" pipes.

Such an electrical connection, without any doubt, will cause the effects produced on the return pipe mentioned above.

Chemical analysis were made of the earth surrounding the return pipe and the scale taken from the same.

The following are the results:

	Soil.	Scale.
Water	.7	1.4
Silica and Insoluble Matter	81.8	5.8
Iron Oxide	9.6	84.3
Alumina Oxide	2.9	
Magnesia and Cal. Carbonate	4.2	

The character of the iron in the soil was its ready soluble character in dilute hydrochloric acid, showing the recent deposition of the same. The silica remaining in analysis was similar in appearance to the ordinary sand drift of this vicinity; the sands of this vicinity contain from 4-10 of 1 per cent to 1-- 1-10 per cent of iron oxide. The iron oxide in the soil from about the pipe was over 9 per cent. Had the deterioration been caused by ordinary rusting it would not have been disseminated through the earth surrounding the pipe. If the damage was done by an electrical current passing off the pipe in the presence of moisture and carbonic acid, the iron would be disseminated through the surrounding earth.

There is no question but the damage was done by the escaping electric currents. There is also no question but that the electric currents came into the plant from the rails of the Twin City Rapid Transit Company's tracks.

Respectfully submitted,

GEORGE WEITBRECHT,
Principal.

ST. PAUL., MINN., Nov. 16, 1901.

Mr. Geo. Weitbrecht, Prin. Mechanic Arts High School,

DEAR SIR: I have the following report to make respecting the electric currents existing in and about our boiler plants.

On Wednesday, November 6th, the day on which the break in the return pipe was discovered, a connection was made between the return tank and the street car track. A number of pieces of copper wire, the smallest being No. 12 B. & S., were used in making this connection. The wires were strung on dry wooden horses, to prevent connection with the wet ground. The weather was clear, temperature about 40 degrees F.; the slight snow on the ground was thawing. The voltmeter showed a difference of potential of two volts between the boiler system and the tracks, the return tank being positive.

The maximum strength of this current was shown to be 6 amperes and the average strength was 5.5 amperes. These observations were taken at noon. At about the same time the following day, Thursday, November 7th, these observations were repeated with practically the same results. On Sunday morning, November 10th, at 4:30 o'clock, the same connections were made, but the voltmeter showed practically no current. The needle of the instrument merely wavered, and so slightly that no reading could be made.

Of course the ammeter also showed the existence of an exceedingly small current--so small that we were unable to estimate the quantity, although we were using an ammeter graduated in tenths of an ampere. About fifteen minutes after we had finished our observations and were winding up the wire, the early morning mail car passed. This would explain the existence of the slight current just mentioned.

Another test was made on Wednesday afternoon, November 13th. An iron rod, 1 inch in diameter and 6 feet long was driven into the ground in the basement of the school and about 20 feet distant from the return tank. Connection was made between this iron bar and the return tank, and upon introducing a galvanoscope a current was found to be passing from the boiler plant to the earth. The difference of potential as shown by the Weston voltmeter was found to be 1-10 of a volt.

In all of the above tests it was found that the boiler plant was

positive—i. e., that electrode from which the current was passing and upon which the oxygen resulting from decomposition of water would accumulate.

Respectfully submitted,
W. H. McCLINTOCK.

ST. PAUL, MINN., Nov. 22, 1901.

Mr. John Caulfield, Secretary Water Dept.,

DEAR SIR: I send you herewith copy of a report made to the president of the school board, Mr. B. Zimmermann, with regard to the electrolysis that affected a return pipe of the steam plant of the school building located at the corner of Wabasha and Central. This report will probably be of interest to you in connection with the report on electrolysis of the water pipe system.

Yours very truly,
O. CLAUSSEN,
City Engineer.

Nov. 26, 1901.

A. J. Stobbart, Esq., Asst. Corporation Attorney, City,

DEAR SIR: I herewith enclose you copy of report of Professor Weitbrecht, principal of the Manual Training School, to the president of the school board, under date of November 18th, with reference to the damage to the steam pipes on account of electrolytic action. This report was submitted to me by Oscar Claussen, city engineer, thinking it would probably be of interest to this department in connection with his report on electrolysis. Please preserve these papers and return them to me with the other reports which you have, at as early date as possible, as it is the desire of the board that it take such action as you think proper. It is also desired to have the report printed as soon as possible.

Very truly yours,
JOHN CAULFIELD,
Secretary.

To the Members of the American Water Works Association:

Your Special Committee on Electrolysis, appointed to make recommendations for the guidance of the Association in dealing with the problem, and to formulate, for your approval, an expression of the attitude of the Association on this question, respectfully begs to submit herewith its report:

The following facts are established:

1. A very large number of mains and service pipes have been already actually destroyed by the stray return currents of electric railways operating under the single trolley system, many instances of such destruction of pipes by these currents having been reported from practically every city where the single trolley system has been in use for any considerable length of time. Even where the action is too slow to be immediately discovered, the life of the mains and service pipes is inevitably greatly shortened and their value thereby necessarily proportionately decreased.

2. In the single trolley system, no matter how large the capacity of the return feeders, nor how good the bonding of the rails, and even when the continuous rail is used, some electric current will, under the law of divided circuits, flow along the water pipes, the amount of this current bearing the same proportion to the total current used, that the conductivity of the return path of which the water pipes form a part, bears to the total conductivity of all the return paths offered to the current. As neither the rails nor the pipes can practically be insulated from the soil in which they are laid, the proportion of current conveyed by the pipes is considerable, even with the best track-bondage known to modern science, including the welded joint.

3. The electric current, once on the pipes, must leave them to return to its source, the generator; and wherever the current leaves the pipes to pass through the soil, the pipes are damaged.

4. Electrolysis also results from differences in potential between water pipes and any other underground metal conductor such as gas pipes, and as long as the return current is not entirely removed from the earth, such action will continue.

5. The extent of the electrolytic injury at any point is directly proportionate to the number of amperes of current leaving the pipe. The smallest measurable difference of potential is sufficient to produce electrolysis.

6. A cast-iron water main is not a continuous electric conductor, and its joints offer very much higher resistance than an equal length of the plain pipe.

7. The inevitable effect of any resistance at the joints is to cause a part of the current carried on the pipes to be shunted around the joint either through the soil on the outside or through the water on the inside, or by both paths.

8. Wherever the current leaves the pipe to pass around the joint, either outside or inside, or both, the pipe is injured. The action of the fraction of an ampere flowing around successive joints will in time do great aggregate damage to any cast-iron main on which it flows.

Your Committee is convinced, after careful consideration of reliable data on the subject, that there is no known practical method by which owners of underground pipes can protect them against electrolytic injury from single trolley currents, but that there are two methods of operating electric railways by which the return currents can be kept out of the ground: namely, the conduit system as in use in New York City and in Washington, D. C., and the double overhead trolley system as operated in Cincinnati, Ohio, and on suburban lines in the District of Columbia.

The conduit system is more expensive to construct, and is peculiarly adapted to the larger cities. The first cost of installing a double trolley system would be a little greater than that of a single trolley system for the same service; while the cost of converting an existing single trolley system to a double trolley system would be trifling as compared with the enormous interests endangered by the single trolley current.

Ten years experience with the double trolley in Cincinnati proves that that system is entirely practical, possesses many advantages over the single trolley, is more economical in operation and maintenance, and that it completely stops the injury to the pipes.

Your committee therefore respectfully makes the following recommendations:

1. Street railway companies should be compelled, as are electric light companies, and all other electric power companies, to provide a complete metallic circuit for their current, absolutely insulated from the rails and ground. This will keep the return currents out

of the ground and off the pipes, and can be accomplished either by the conduit system or by the double overhead trolley system.

2. No connections by which a current is carried to the pipe, or induced to flow thereon, should be allowed from pipes to rails, or to other return conductors; and no other alleged remedy which permits the mains to carry any portion of the return current, should be countenanced by those in charge of water works plants. Even the failure to prohibit or to protest against such connections might be construed by law to be a tacit consent on the part of the water works management to the use of the pipes as conductors, and might relieve the electric railway company from responsibility for the injury which would inevitably result if the mains were allowed to convey current.

In the further discharge of the duties for which it was appointed, your committee respectfully submits for your approval the following preamble and resolutions, as an expression of the attitude of this Association on the question of electrolysis:

"WHEREAS, The report of the special committee on electrolysis shows that wherever the single trolley system is in use, a portion of the return electric current will flow on the water pipes, and that whenever water pipes become positive to rails or gas pipes or other underground metal structures, the water pipes are injured; and that whenever water mains, whether positive or negative to the rails, convey electric current, they are liable to injury thereby, near the joints; and,

"WHEREAS, It further appears from the said report that there is no known practical method by which owners of water pipes can protect themselves against electrolytic injury resulting from the operation of single trolley cars, but that electric railways may, by means of the conduit system or of the double overhead trolley system, be operated successfully and economically and without any injury to the water pipes; now, therefore, be it

"*Resolved*, That the American Water Works Association, as a national organization, herewith unanimously maintains that street railways have no right to so operate their cars as to cause injury and destruction to water pipes; and be it further

"*Resolved*, That street railways now operating under the single trolley system ought to be required to remove their return current

from the ground, and that if they continue to operate by current transmitted from the power station to motors on the cars, they should be required to provide a complete metallic circuit of sufficient capacity to convey all the current, and in a manner absolutely to insulate it from the rails and from the earth."

DABNEY H. MAURY,
G. H. BENZENBURG,
J. WALDO SMITH,
Special Committee on Electrolysis.

The resolutions were adopted by the American Water Works Association at its convention held in New York City in June, 1901.

No. 1. 16 INCH MAIN, DALE STREET SOUTH OF UNIVERSITY AVENUE, OPPOSITE T. C. R. CO'S. ROTARY TRANSFORMERS. JULY 11, 1901.

No. 4. 6 INCH MAIN, PLEASANT AVENUE IN FRONT OF PEOPLES CHURCH. JUNE 28, 1901.

No. 5. 16 INCH MAIN, DALE STREET—100 FEET SOUTH OF SELBY AVENUE. JUNE 19, 1901.

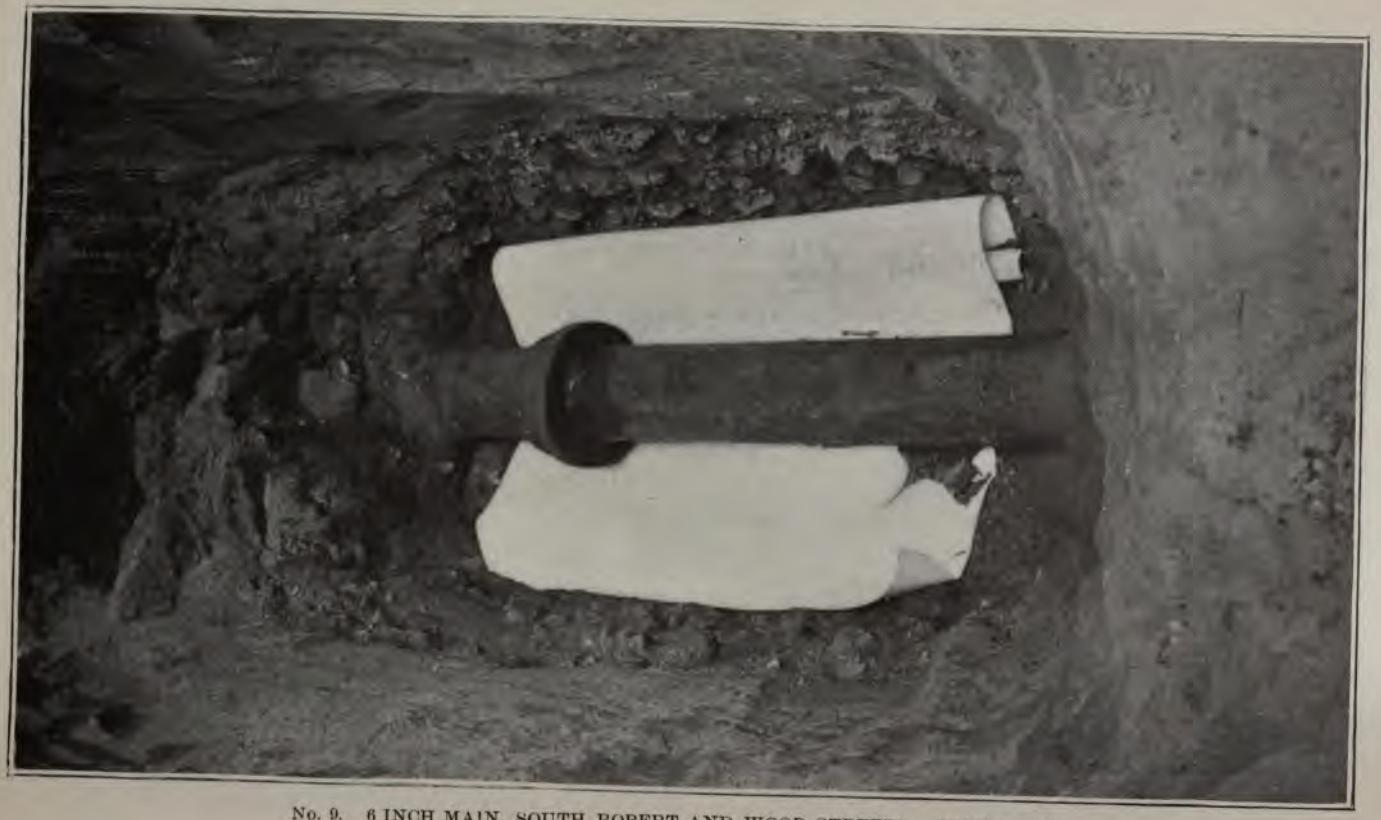
No. 6. 16 INCH MAIN, EAST SEVENTH STREET AND PHALEN AVENUE. JULY 15, 1901.

No. 5. 16 INCH MAIN, DALE STREET—100 FEET SOUTH OF SELBY AVENUE. JUNE 19, 1901.

No. 8. 6 INCH CROSS, SOUTH WABASHA AND DELOS STREETS. JULY 17, 1901.

No. 9. 6 INCH MAIN, SOUTH ROBERT AND WOOD STREETS. JULY 18, 1901.

No. 10. 30 INCH MAIN, MISSISSIPPI STREET AND PENNSYLVANIA AVENUE. JULY 22, 1901.



No. 9. 6 INCH MAIN, SOUTH ROBERT AND WOOD STREETS. JULY 18, 1901.

No. 12. 10 INCH MAIN, JACKSON AND TWELFTH STREETS. JULY 24, 1901.

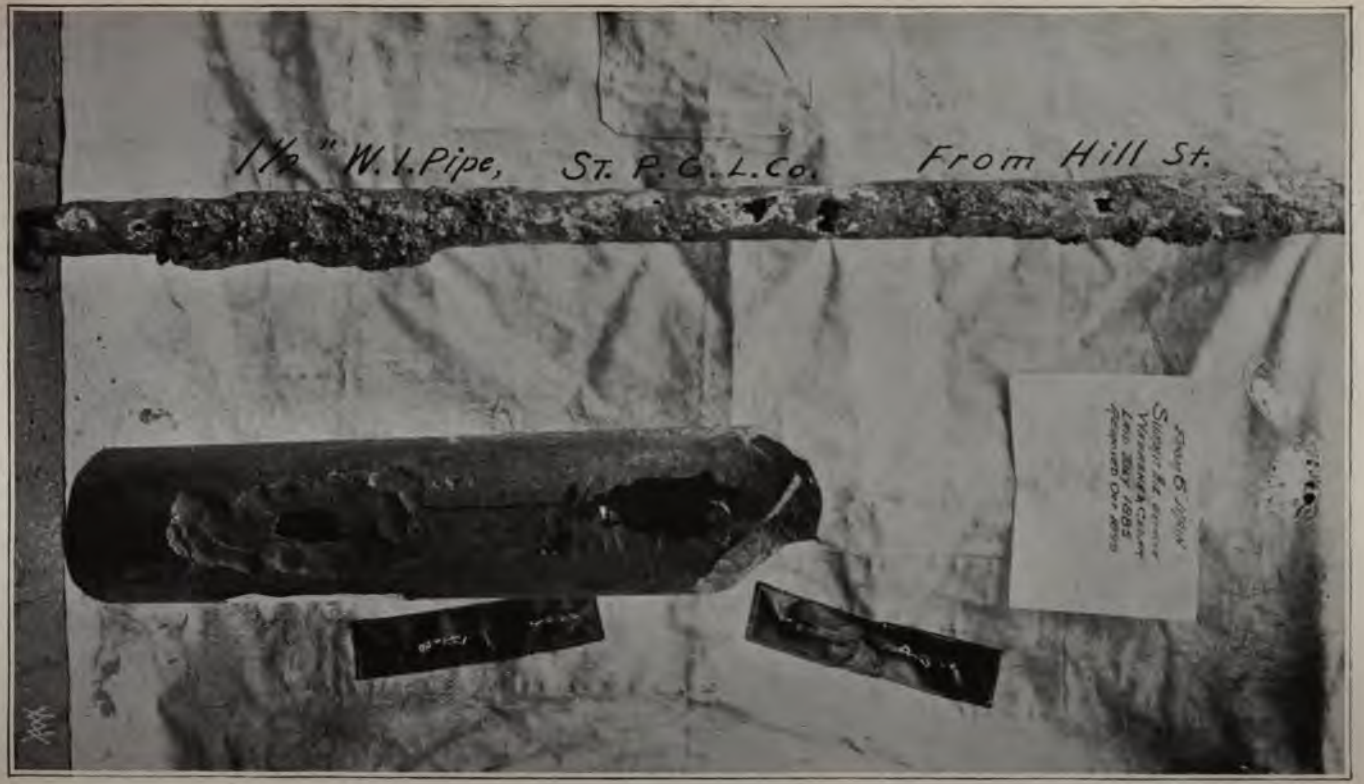
No. 13. 4 INCH MAIN, ON WALNUT STREET SOUTH OF SEVENTH STREET. AUGUST 24, 1901.

No. 14. 12 INCH MAIN, TENTH AND JACKSON STREETS. AUGUST 24, 1901.

No. 15. 6 INCH MAIN, SELBY AVENUE AND NINA AVENUE. AUGUST 16, 1901.

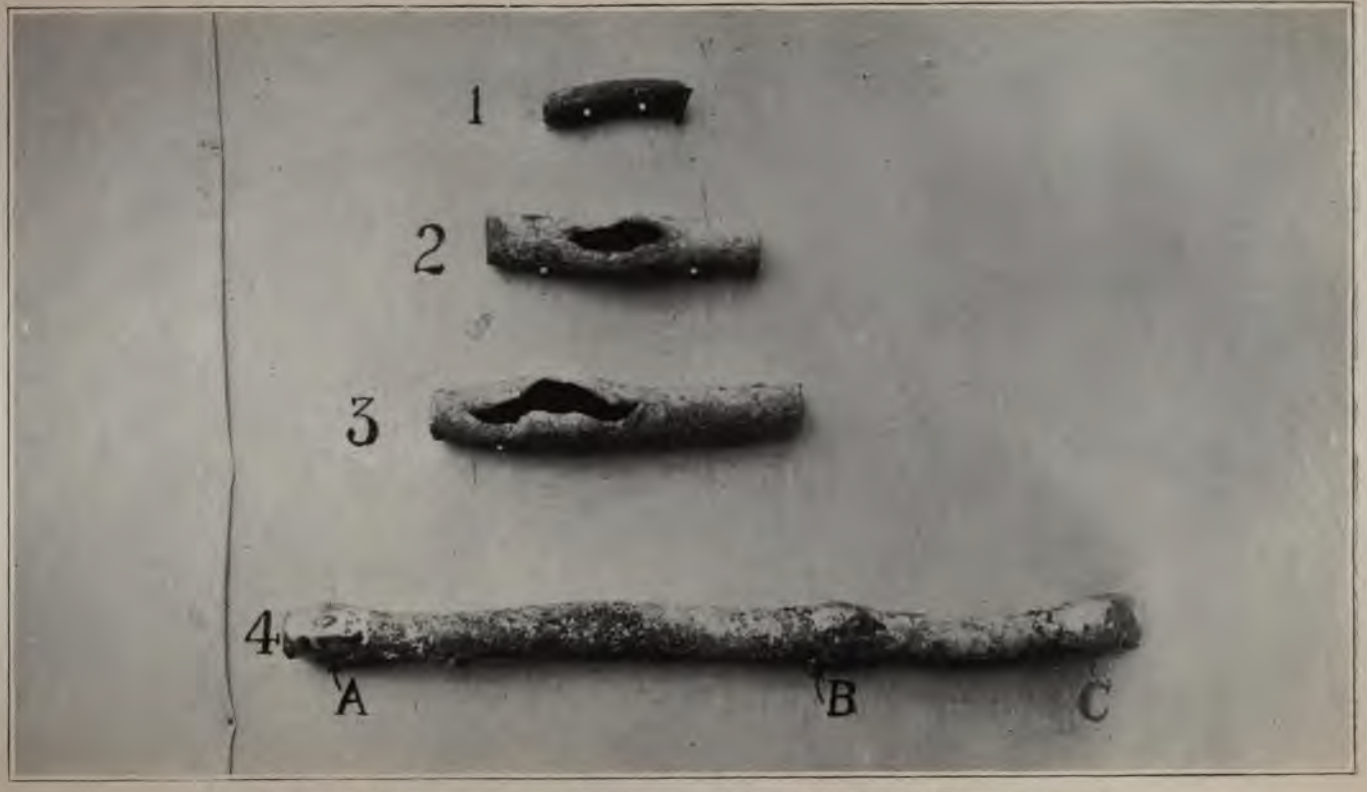
No. 14. 12 INCH MAIN, TENTH AND JACKSON STREETS. AUGUST 24, 1901.

No. 17. LOW PRESSURE MAIN ON OVERTON AVENUE, 1000 FEET NORTH OF MARYLAND AVENUE. SEPTEMBER 11, 1901.



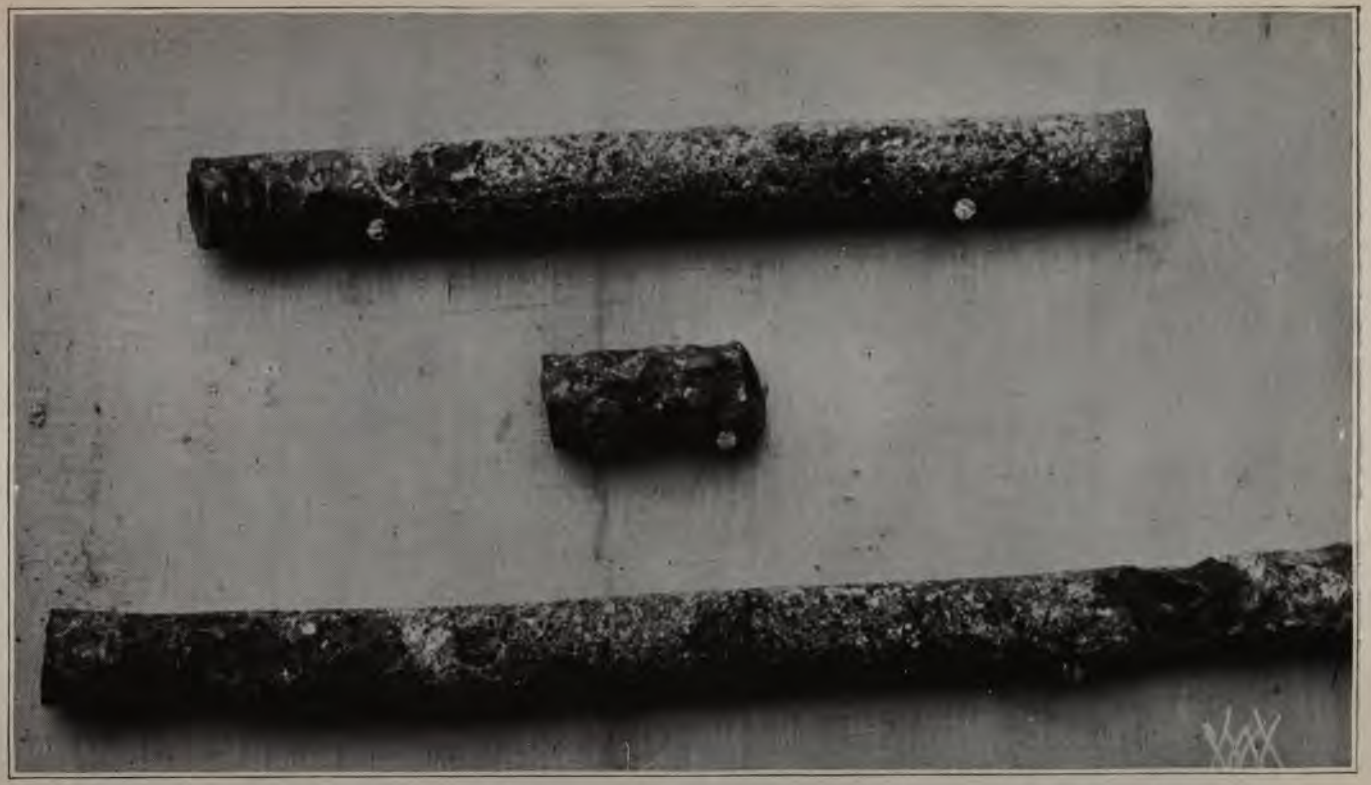
No. 18. 6 INCH WATER MAIN AND 1½ INCH GAS PIPE.

No. 17. LOW PRESSURE MAIN ON OVERTON AVENUE, 1000 FEET NORTH OF MARYLAND AVENUE. SEPTEMBER 11, 1901.



No. 20. LEAD SERVICE PIPES FROM COURT HOUSE AND CITY HALL. (See Report.)

No. 21. LEAD SERVICE PIPES FROM CITY HALL AND COURT HOUSE (BACK VIEW OF PHOTO. No. 20.)



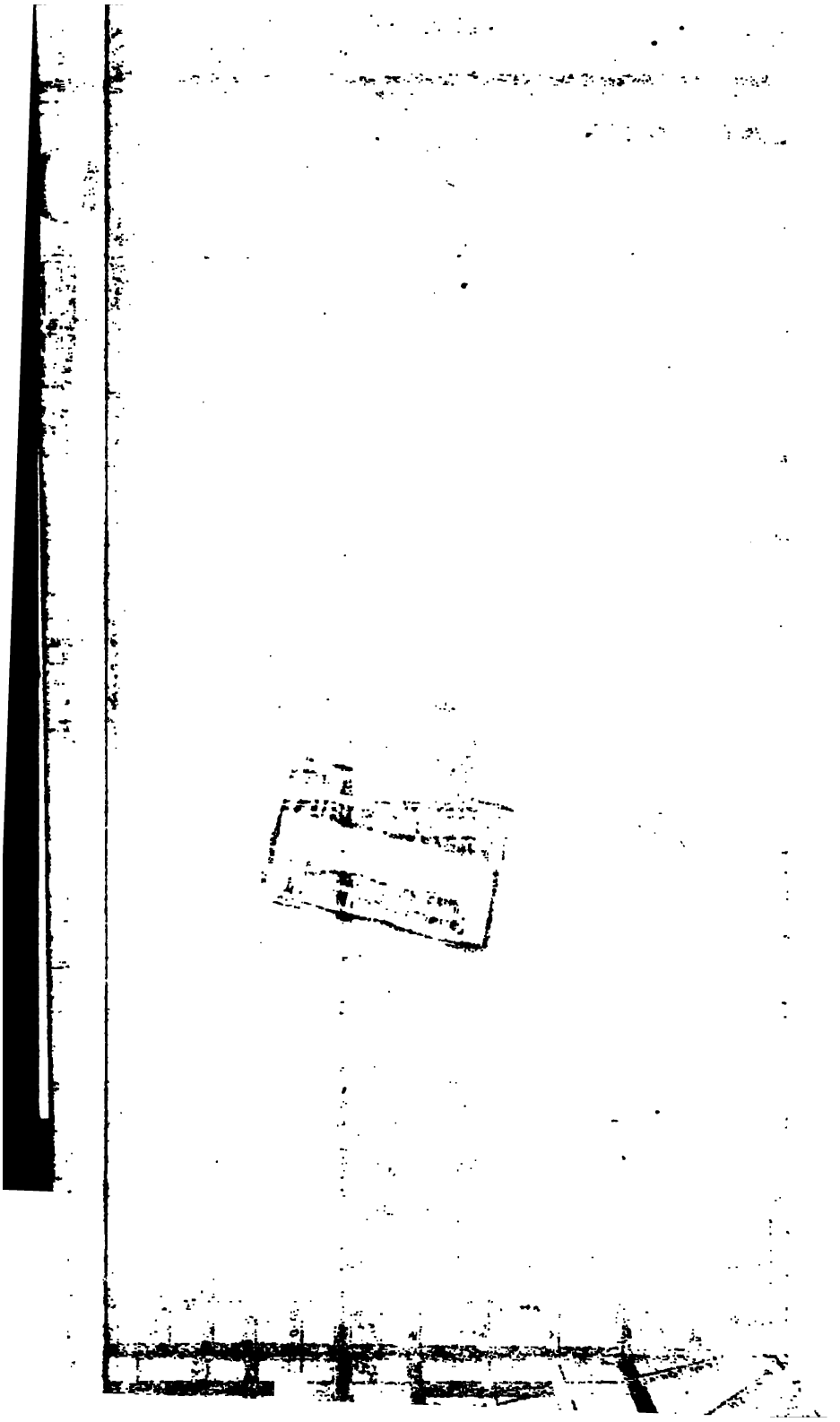
No. 22. ⅝ INCH LEAD PIPE REMOVED FROM 690 UNIVERSITY AVENUE SEPTEMBER 9, 1901. LAID SEPTEMBER 9, 1890.

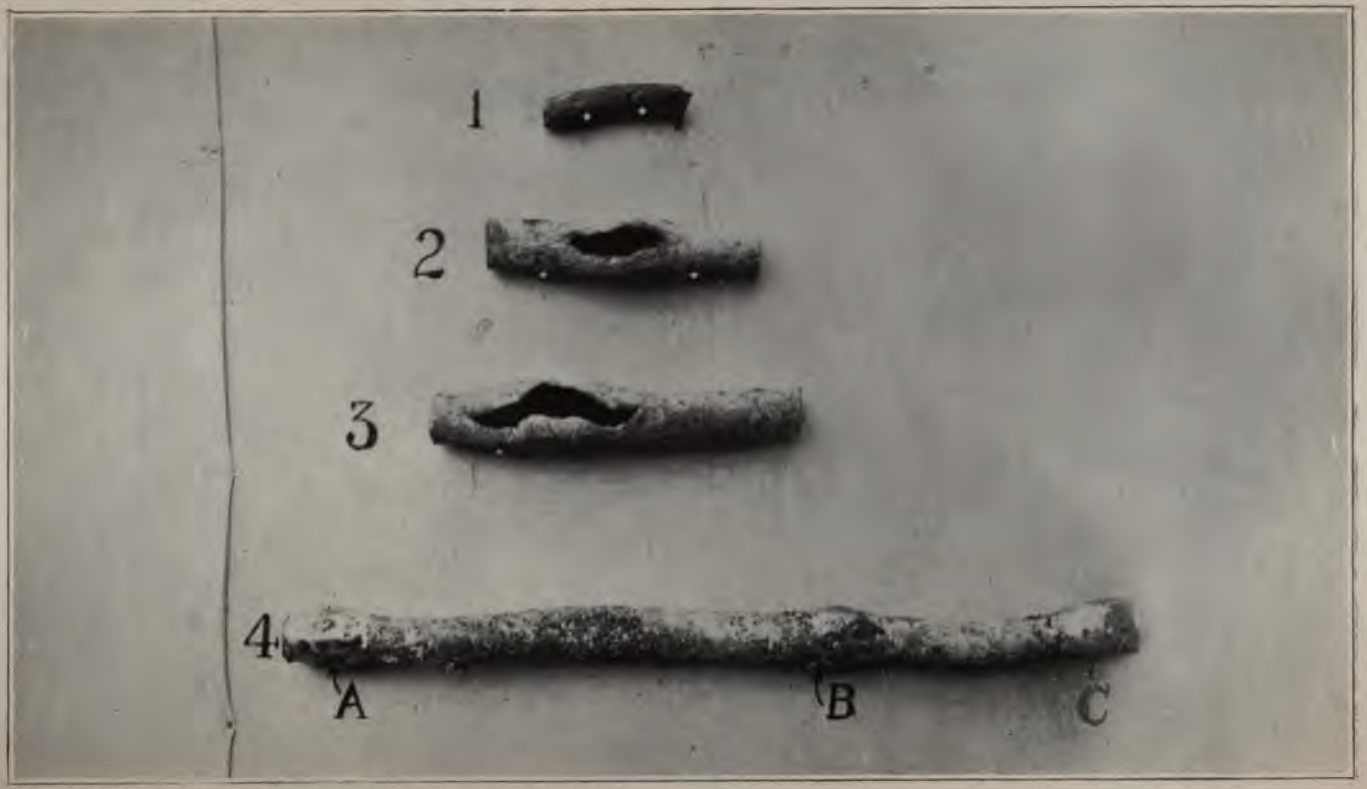
No. 21. LEAD SERVICE PIPES FROM CITY HALL AND COURT HOUSE (BACK VIEW OF PHOTO. No. 20.)

No. 24. UNIVERSITY AVENUE, NEAR ST. ALBANS STREET.

No. 26. HIGH PRESSURE RESERVOIR, LOOKING EAST. SEPTEMBER 13, 1901.

No. 24. UNIVERSITY AVENUE, NEAR ST. ALBANS STREET.





No. 20. LEAD SERVICE PIPES FROM COURT HOUSE AND CITY HALL. (See Report.)

No. 21. LEAD SERVICE PIPES FROM CITY HALL AND COURT HOUSE (BACK VIEW OF PHOTO. No. 20.)

No. 22. ⅝ INCH LEAD PIPE REMOVED FROM 690 UNIVERSITY AVENUE SEPTEMBER 9, 1901. LAID SEPTEMBER 9, 1890.

No. 23. HIGH PRESSURE MAIN, DALE STREET, ABOUT 300 FEET SOUTH OF RESERVOIR ROAD. SEPTEMBER 13, 1901.

No. 24. UNIVERSITY AVENUE, NEAR ST. ALBANS STREET.

No. 26. HIGH PRESSURE RESERVOIR, LOOKING EAST. SEPTEMBER 13, 1901.

No. 25. HIGH PRESSURE RESERVOIR, LOOKING EAST. SEPTEMBER 12, 1901.